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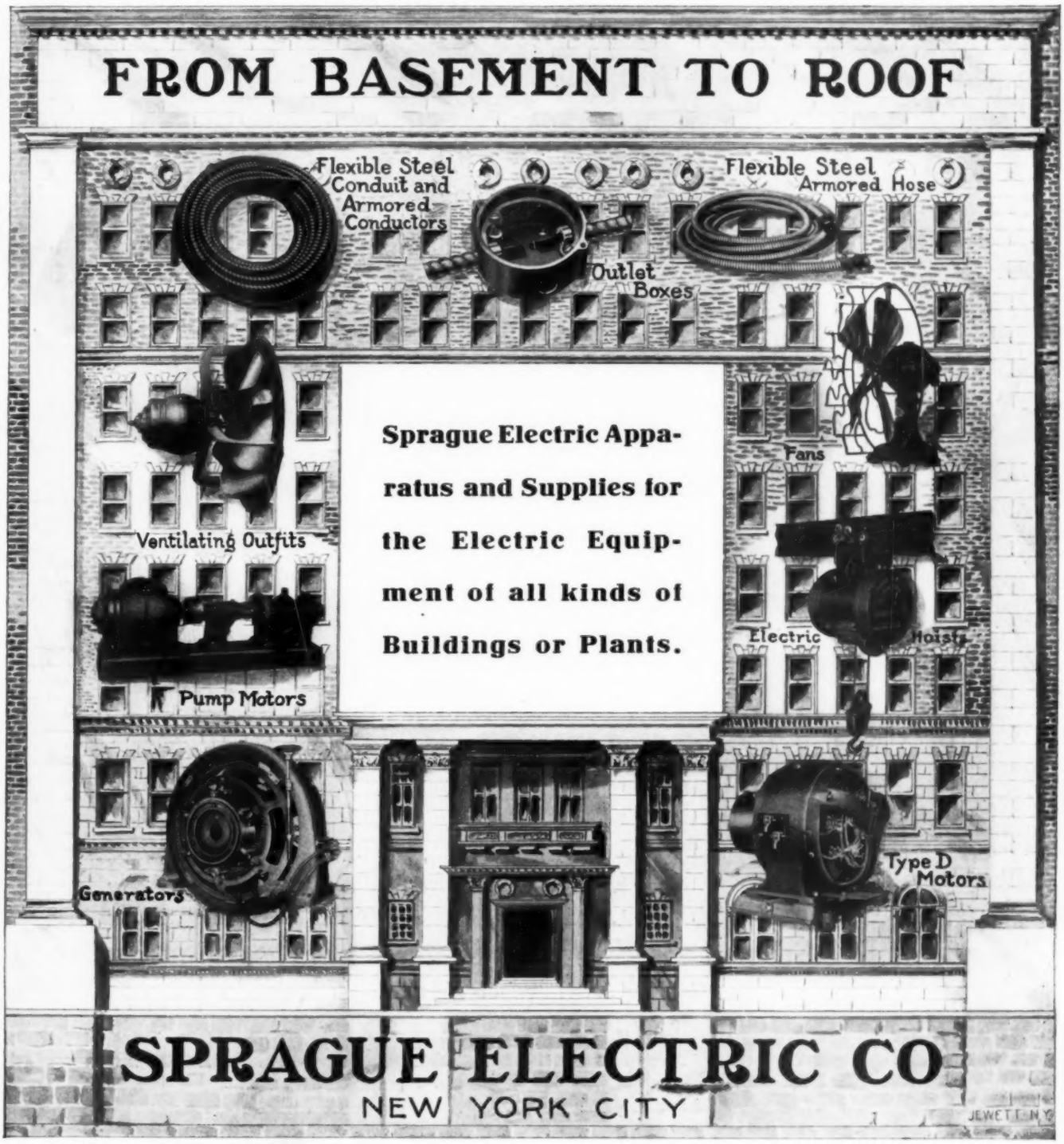

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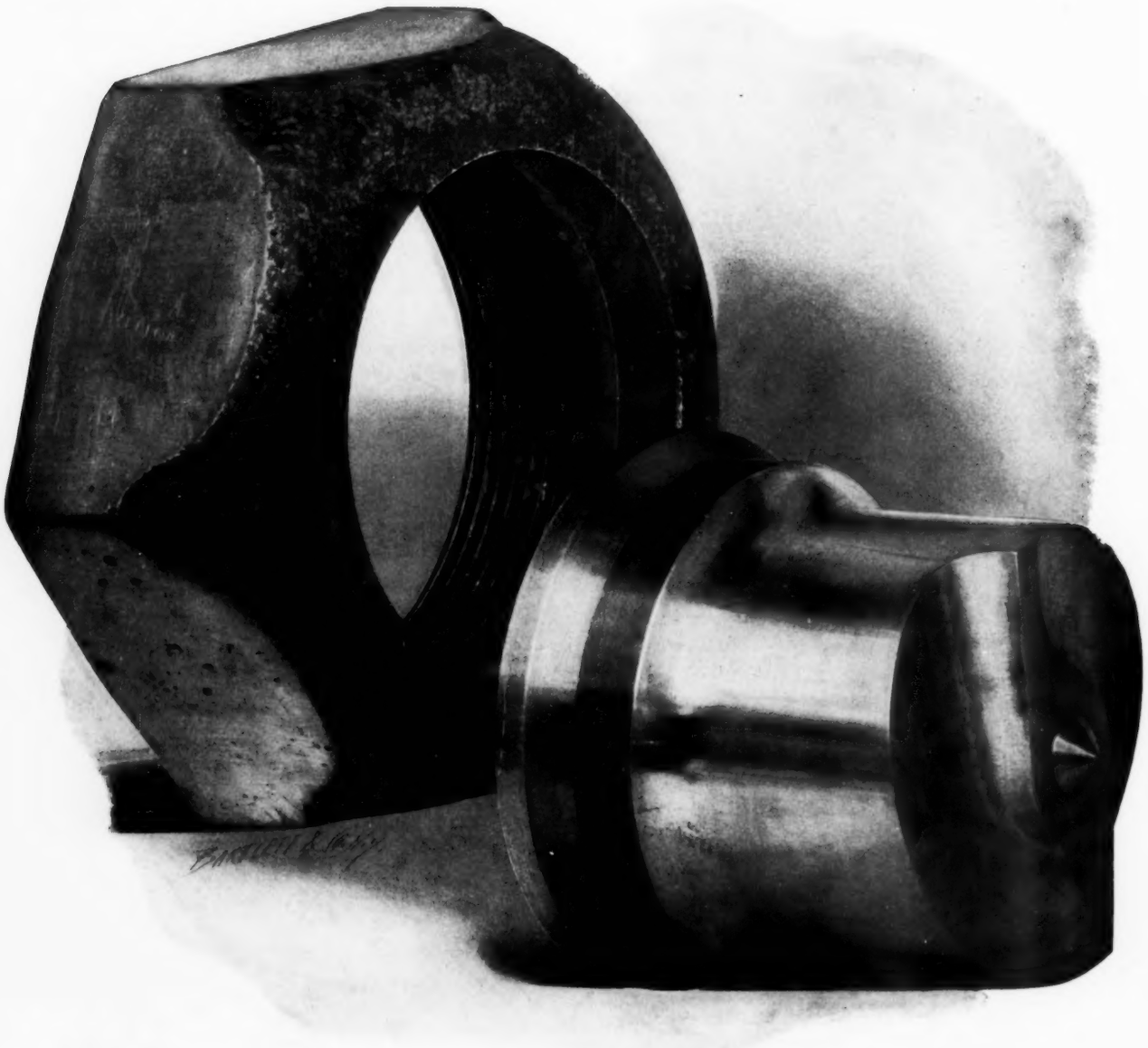

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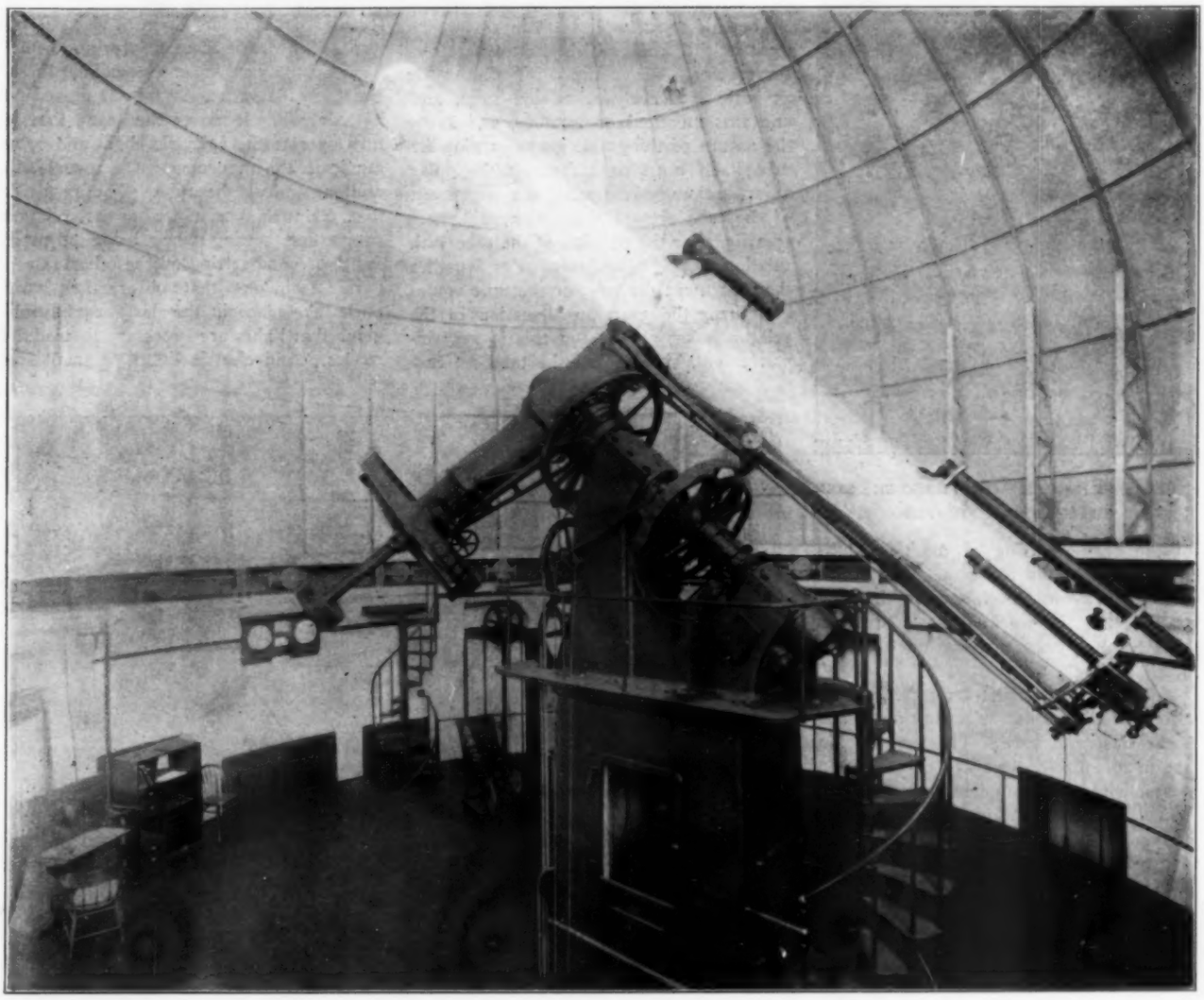
The Machinery of a Big Telescope.

BY C. H. CLAUDY.

This title will seem strange to those whose conception of a telescope includes only a piece of glass at each end of a long tube. And a small telescope may be as simple as that; but when the tube is nearly 60 feet long and weighs over 6 tons, as is the case with the Yerkes instrument, considerable machinery is necesary to move it around. Moreover, the instrument must be housed, yet in such a manner that the objective end can be pointed to any part of the sky. This is accomplished by having a dome over the instrument, which is provided with a slit, closed by a shutter, and the whole dome is revolved to allow this slit to face any desired point of the compass.

This type of instrument, the equatorial, is the largest and heaviest piece of truly scientific apparatus extant. They are extremely expensive, and consequently are not numerous. But America has the two largest in the world, and besides them, another very famous one, the 26-inch equatorial refractor at Washington, D. C., with which the moons of Mars were discovered in 1877. It is of this instrument that the photographs here used as illustrations were taken.

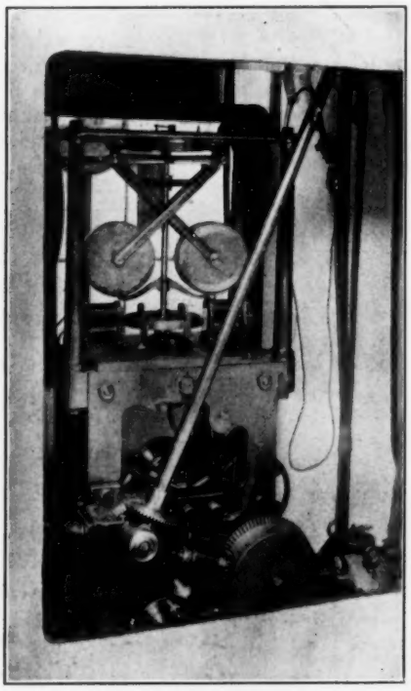
An equatorial telescope is one mounted on two axes, one of which is parallel to the axis of the earth, and the other at right angles to it. By combinations of the movements of these two axes, any point in the sky may be examined through the instrument. The polar axis—the one parallel to that of the earth—is made to rotate in a reverse direction to the motion of the earth, by means of a delicate and complicated mechanism, and as the speed of rotation is exactly that of the earth, the telescope, once pointed at any heavenly object, remains pointed at that object in spite of the earth's motion. For as fast as the earth carries the telescope tube out of line with the heavenly object, by its revolution toward the east, the clockwork motor carries it back toward the west, and the two glasses are kept accurately in line with the star planet being examined. This is the principle of the equatorial, and of course the mechanism which moves the tube must be of the most exact and delicate character. In the Washington instrument the motor is driven by a weight, as giving a constant power not subject to fluctuations. Reference to the two illustrations will show that the mechanism is governed by a peculiar centrifugal governor, invented and applied to telescopic



26-INCH REFRACTING TELESCOPE IN THE NAVAL OBSERVATORY, WASHINGTON.

clock use by Professor Youngs, the famous authority on the sun. In addition to this a fly-wheel may be seen, bearing at regular intervals on its periphery armatures, which pass between electric magnets. These magnets are to be connected to a chronographic clock by the electric circuit, so that at certain regular intervals, say half-seconds, an impulse is sent into them. They thus correct inequalities in the mechanical governor, for if the clock is gaining, the sudden magnetic impulse on the armature acts as an instantaneous brake; while if the clock loses, the impulse acts as an accelerator. The mechanical movement is so nearly perfect in this instance, however, that the electric correction apparatus is not used.

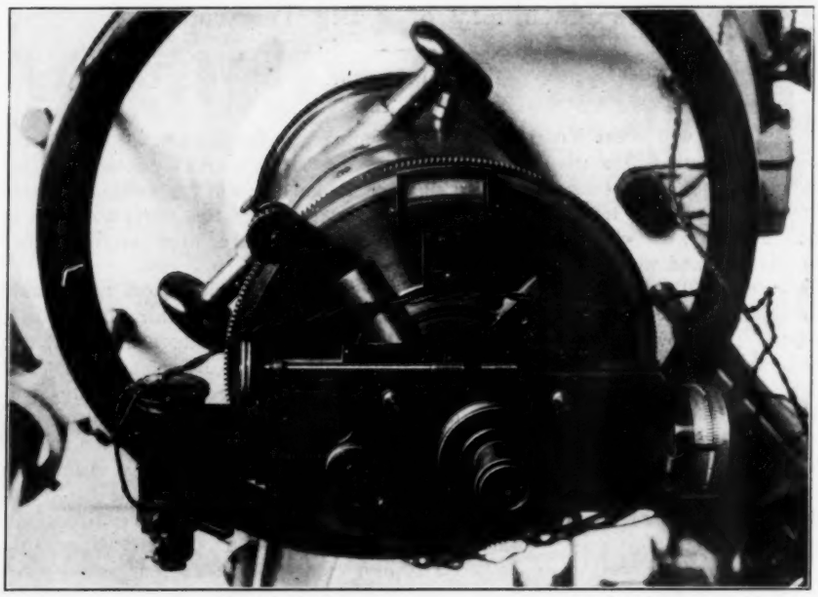
The heavy shaft which crosses the mechanism diagonally, passes up to the edge



CLOCK MECHANISM OF TELESCOPE SEEN THROUGH DOOR IN PIER.

of the heavy bearing of the polar axis, where it operates a worm. This worm engages a worm wheel, seen in the illustration; but the worm itself is protected by a band of brass, to keep out dust and grit.

All such instruments are provided with two sets of motions for setting the instrument—fast and slow. The fast motions are in this machine worked by a series of gears, with power applied through ropes, pulled by the operator. These serve to swing the tube on either axis until it is approximately in the required position. Then the slow-motion handles are brought into play (seen at the eye end of the tube), and by their use the tube is oriented exactly. Both axles are provided with coarse scales, for rough setting and with fine silver scales, with divisions so small they are read with micro-

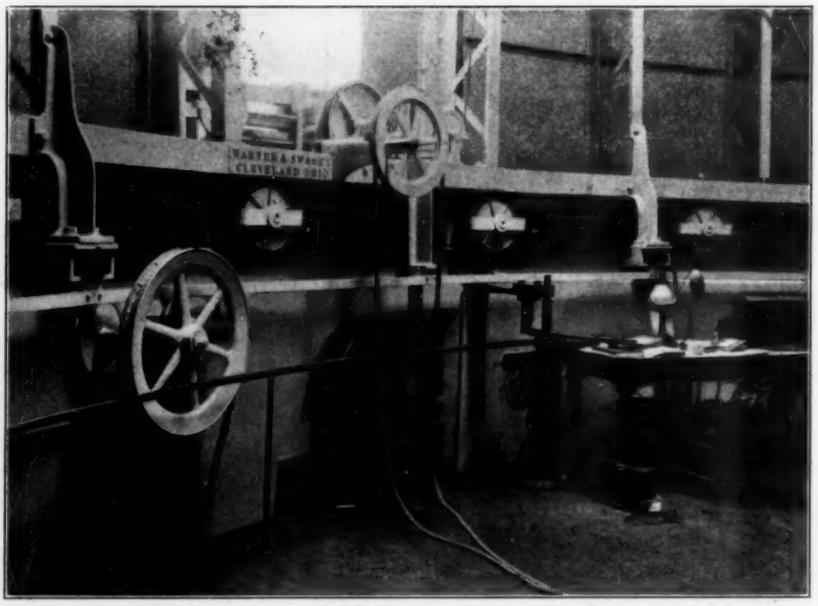


MICROMETER EYE-PIECE OF TELESCOPE.

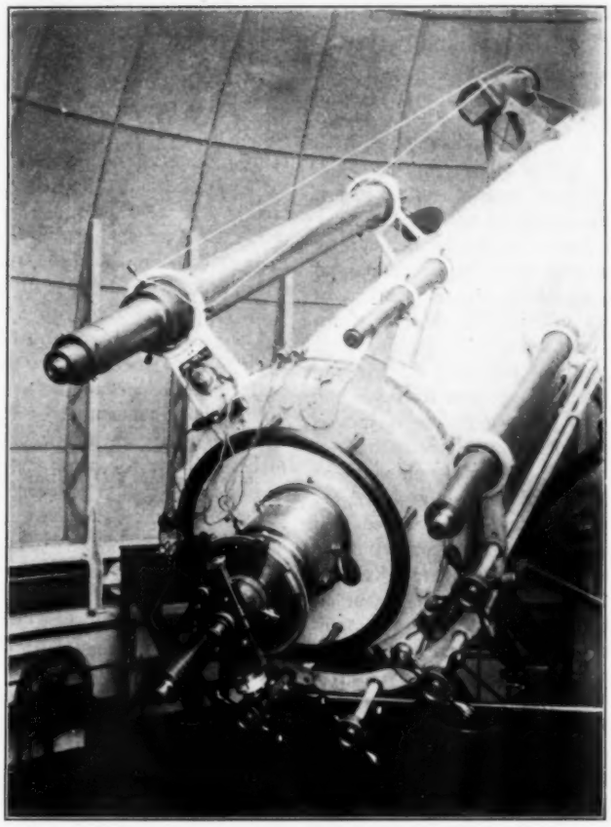
scopes, in the form of tubes on the outside of the telescope tube proper, which get their images through a series of prisms.

There is one complication in an instrument of this kind, which the average observer would never think of. Inasmuch as both axes are worked by gears, and one axis mounted on another, and as in the nature of things the gears turning the tube itself must pass through the polar axis (stationary bearings), any movement of the tube around the axis would, necessarily, alter the position of the tube with relation to the other axis. For whether the gear turns the tube, or the tube moves and turns the gear, an alteration in the relation takes place. But this is very inconvenient. If one has the tube set correctly for one scale, and wishes to move it for the other, the one setting must remain unchanged by the movement. To effect this, an epicyclic chain of gears is interposed in the mechanism, working somewhat on the plan of an automobile differential, so that when the tube is moved on its axle, while it moves the gears, they in turn operate the epicyclic chain and communicate the movement in a reverse direction against the tube. The result is that the tube does not alter its relation to its first setting when being adjusted for the second setting on the other axle.

It is obvious that observation work must take place in the dark—equally obvious that lights are necessary to read the circles. And electric lights of small size



DOME-MOVING WHEEL AND ROPE TO SLIDE SHUTTER OPENING. HANDLE CONTROLLING FLOOR MOVEMENT TO LEFT OF DESK.

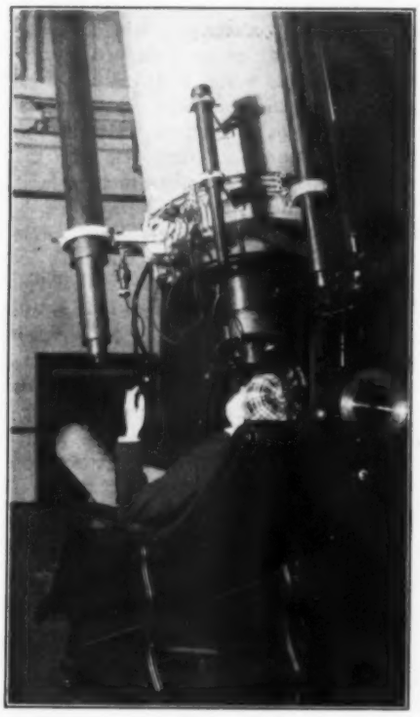


EYE END OF 26-INCH TELESCOPE AT WASHINGTON SHOWING SMALL ATTACHED TELESCOPES USED AS "FINDERS," FOR READING DISTANT VERNIERS, ETC

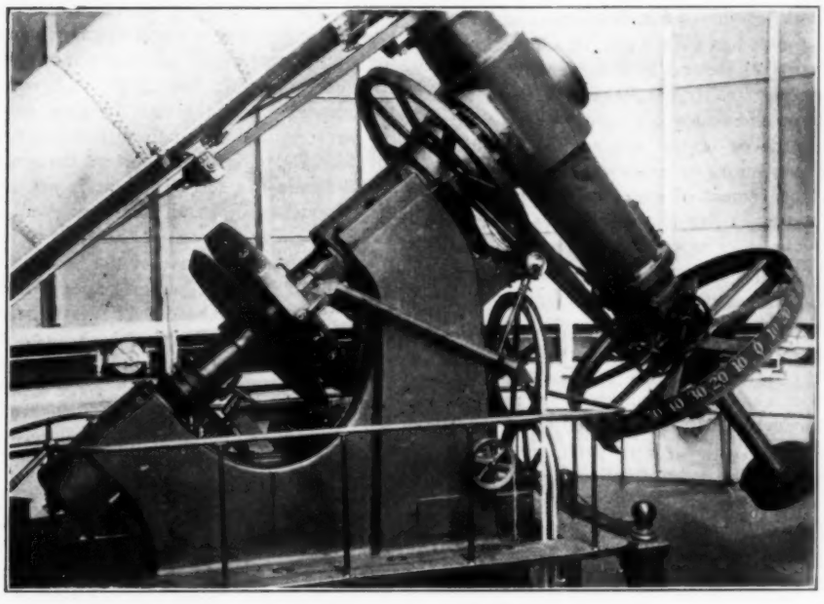
stud the mechanism; all these can be operated from the eye end of the tube. This also means endless complication, and several sets of commutators and brushes, so that the electric current is not interrupted by movements of the tube.

Sometimes the object to be examined is overhead—then the observer is almost beneath the tube, as in the illustration. At other times the tube will be nearly horizontal. Now this means either that the observer must climb up on a ladder to look through the telescope, or be elevated in some other way. And so he is, for the entire floor of the dome rises and falls, like an elevator. In the illustration showing the desk, a horizontal lever is seen. This controls the water supply which works the four hydraulic rams beneath the floor, which raise and lower the floor. The four corners of the floor frame, where the rams are, are all connected with shafts and gearings working in toothed racks, so that no one side can rise faster than any other side, thus preventing jamming through a greater pressure on one ram than on another.

The dome itself, 60 feet high, 45 feet across and weighing 24 tons, rotates on traveling wheels, which rest on a track, and which in turn support the dome which rests upon them, on another track. The dome is turned by hand, the lower wheel in the illustration being turned by pulling a rope. The upper wheel with the rope operates the shutter, 8 feet wide, which extends from the bottom of the dome to its top, and which is closed in bad weather, or when the telescope is not in use. The slit being so much wider than the telescope glasses, once set, it need not be moved until the slow motion of the clock brings the object-glass past one edge. Then a pull on the rope rotates the dome, and sets the slit again in position.



THE TELESCOPE IN USE. PROF. SEE, U. S. N., IN OBSERVER'S CHAIR.



THE TWO AXES ON WHICH THE TELESCOPE IS MOUNTED.

Of course there are endless little pieces of mechanism about an instrument of this kind, interesting enough in their way, but requiring too much space to describe. There is the delicate micrometer eyepiece, for instance, by means of which the position angle of two stars is determined, and stellar measurements made—in which a fine screw moves a spider net too fine for naked sight to see and moves it with an accuracy which cannot be measured, or hardly, by infinite means. There are the extra dials which record the position of the telescope on the side of the pier, worked in their turn by delicate gears, all of which must run down the axes as do the larger gears. There are the locking

handles, by means of which the slow motions are thrown in and out of gear, and the tube clamped in position so that it cannot be moved except by the clockwork. There are dozens of such devices. Is it any wonder that the machinery for pointing a bit of glass at the sky and keeping it in position cost a round $25,000?

I speak of a bit of glass as if that were the least important part of the telescope, but the truth of the matter is that the two pieces of glass which form the objective of this telescope, are valued at more than the price of the mounting, and took years to make. But the history of lens-making is another story, and need not be entered into here.

Those versed in mechanics will doubtless contend that the flexure impossible to avoid in heavy machinery, when a great weight is swung counterbalanced on the end of a shaft, would interfere with the accuracy of astronomical observations. And so it does, in original determination of the relation of a certain star with the earth—its right ascension or time, or hour angle, in other words. That work is left to the transit, meridian circle and prime verticle instruments, devices of most marvelous delicacy, but restricted to one kind of work. But the equatorial can determine with great accuracy the relation of one star to another star, since the flexure is the same for both. And it is in this work that the machinery of the equatorial plays its greatest part, although the observations on planets, asteroids and comets is all done, or mostly done with instruments of this type.

The making of telescopic mountings is an art, and it should be a matter of pride to Americans that the firm of Warner & Swazey is now in the front rank among makers of such instruments throughout the world.

Eight hundred tons per annum of vanadium steel alloys are now being produced at the Queensferry works of Willans & Robinson, according to a paper by J. Kent Smith read before the Liverpool section of the Society of Chemical Industry. It is stated that the vanadium steel industry is altogether an English industry, 80 per cent. of the production being used in automobile construction. Remarkable properties are shown by the chrome-vanadium steels, containing 10 to 20 per cent. of vanadium, a maximum breaking stress of 103 tons per square inch having been attained after special heat treatment. The material has also the peculiar feature of combining with this great strength a high resistance to dynamic and torsional tests. The nickel-vanadium steels were also of great strength but did not show such resistance to dynamic and torsional tests.

Progress on the Pennsylvania Railroad's North River tunnels is reported to be very rapid.

An Electrical Measuring-Machine for Engineering Gages and other Bodies.

BY P. E. SHAW.

PRELIMINARY.

End-standards of length, called gages, are tested and compared with one another by means of measuring-machines, made by many engineering firms in England and abroad. These machines are identical in principle, and differ little in form from the original one invented by Sir Joseph Whitworth. Their principle is that the gage rests against one jaw, fixed, of the machine, while the other jaw is moved forward by a micrometer screw until it touches the gage. Compression, more or less, of machine and gage, is required before any indication can be obtained that both jaws are firmly in contact with the gage. These machines will in future be spoken of as mechanical-touch machines, as distinguished from the new machines called electric-touch machines. In practice it has been found desirable to introduce some index of the touching—e.g., a gravity-feeler, spirit-level, or the raising of liquid in a fine tube.

The weight of the gage, often large, should never, as is sometimes done, be supported by the grip of the two jaws; for then there is considerable end-thrust of the jaws, with consequent longitudinal strain in the machine, in addition to the vertical strain due to the weight of the gage. If the whole or part of the weight of the gage be supported by the jaws, though the latter be parallel to one another initially, they will not be so after being weighted. The errors which enter into the measurements made by these machines differ in kind and degree according to the nature of the gage. There are three kinds of gage.

A. *Bar Gages with Plain Parallel Ends*—Each jaw has a flat face, and each end of the gage has a flat face. Each of the four faces has defects in planeness, and in being not strictly parallel to the other three. If in addition a gravity-feeler be used, it introduces extra errors. To admit so many errors of unknown amount in the measurement of gages may be permissible in present-day engineering trade practice, but it does not satisfy the demands of exact metrology. Thus, to obtain accuracy, surface contact should be abandoned, and point contact used, and these gages should be measured between two rounded points or spheres, in which case no assumptions are made as to the perfectness or parallelism of the surfaces involved. For such point contact we require a more delicate means of perceiving contact than the mechanical one; hence the electric-touch method is employed. It has been developed by the writer in a series of researches since 1900.

*Abstracted from the Philosophical Transactions of the Royal Society.

B. *Cylindrical Gages*—The flat faces of the jaws touch the cylinder with two line contacts at opposite ends of a diameter of the cylinder. Non-planeness and non-parallelism of the jaw faces, as also imperfections in the cylinder, introduce errors, though these are less serious than for Class *A*. Thus, for accuracy, line contact should be superseded by point contact, the measurement to be made between lines or edges on the jaws, the lines being not parallel with the axis of the cylinder.

C. *Sphere or Bar with Spherical Ends*—The face of each jaw touches the sphere at a point. Since the jaw faces are imperfect, error can only be avoided by providing that the contact of the two faces with the sphere always occurs at the same places. Thus, for accuracy, contact may be made as usual, between flat faces of the jaws, if the surfaces be made true, and contact be always at the same points on the flat faces.

From these remarks it appears that, for each kind of gage, measurement should be made by point contact, the jaws to support no part of the weight of the gage, and the end thrust on them to be reduced as much as possible. The method described below fulfils these conditions, and has in addition the advantage of being more sensitive than the old method.

DESCRIPTION.

The latest form of the machine is shown in Figs. 1, 2 and 3. In general appearance it is somewhat like the usual mechanical-touch machines mentioned above.

There are two headstocks and a table in the center, all resting on a massive cast-iron bed. The headstocks each carry micrometer screws and nuts with graduated heads, and these measure the gage, which rests on and is clamped to the table. The gage being clamped on the table, is set true with respect to the axes of the micrometer screws, by adjustments of the table. The left screw point is brought into electric contact with the gage; then the right screw point is brought into electric contact with the gage, and when the current passes through the gage from one measuring point to the other, the two divided heads are read. To turn the graduated heads the screw system is not actually touched by hand, but is worked by a hand-pulley and string, the former being attached to the base of the headstock, there being a large pulley on, and concentric with, the head. The left headstock is a replica of the right headstock; to save space, only the measuring point of the left headstock is shown. Gage *d* rests on the table *f* and is clamped to it. The table top can be brought into any desired plane by two rotations, as follows:

The table is fitted with five adjustments, being movable through a small angle about a vertical axis, and also through a small angle about a horizontal axis, as well as adjustable in hight. It can further be traversed either along or across the bed.

In Figs. 1 and 3 is shown a nut N, working in bearings E_1, E_2, and having the screw S in it. A steel cone n is screwed into the right end of the nut N, and bears against the stop m. There is a helical spring F which presses forward against the bearing E_1 and back against the nut, forcing the cone n against stop m. The point of n lies truly in the axis of nut N, and the front face of m is ground truly plane, and by a special device is made accurately normal to the axis of the nut N. By this means when the nut is turned, it runs the yoke q and the pulleys r_1, r_2, Fig. 3.

The screw S' would rotate with the nut if free, but as the yoke q which runs on the bracket V is clamped to the screw, the latter acquires a simple translatory movement along its axis, in or out of the nut, according as the latter rotates right or left-handedly. The screw spindle carries an index mark by which the position of the screw in the nut can be seen on the fixed scale S, Fig. 3.

In this micrometer system of rotating nut and translating screw it is essential

The casting R is electrically insulated from the plate W by a mica sheet, and by having the screws which bind R and W bushed with ebonite. The base of plate W is grooved to fit the part X of the bed, and presses that part by four studs; one other stud presses on the flat part Y, Fig. 3. Thus the headstock rests firmly on the bed at five points of support, and has only one degree of freedom—along the length of the bed. Fixed on the side of W is shown a bar V, on which the hand-pulley Z can be pulled forward and

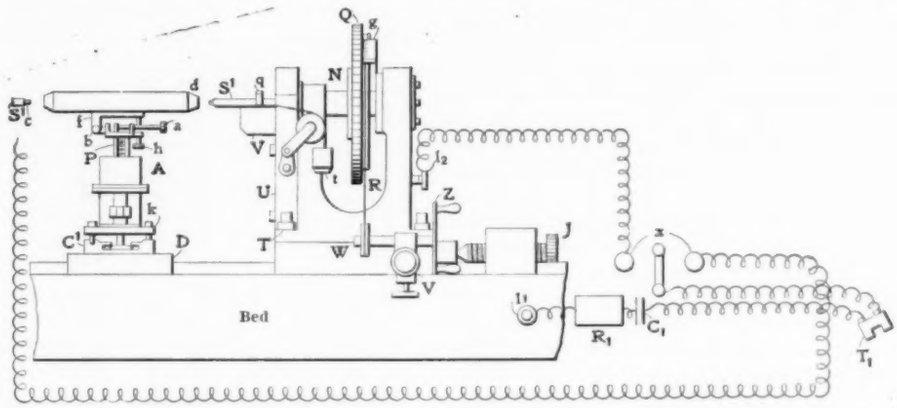


FIG. 1. SIDE AND END ELEVATION MEASURING MACHINE.

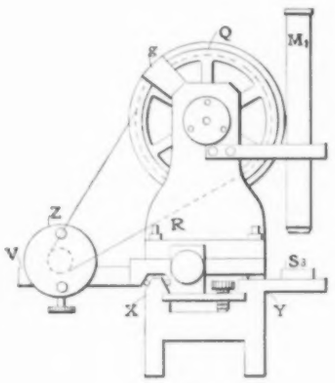


FIG. 2.

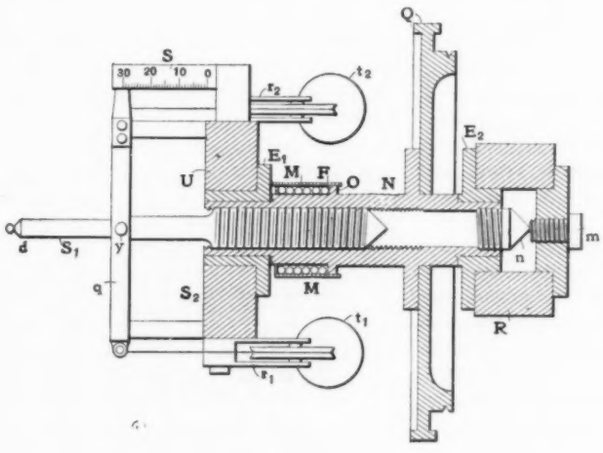


FIG. 3. HEADSTOCK.

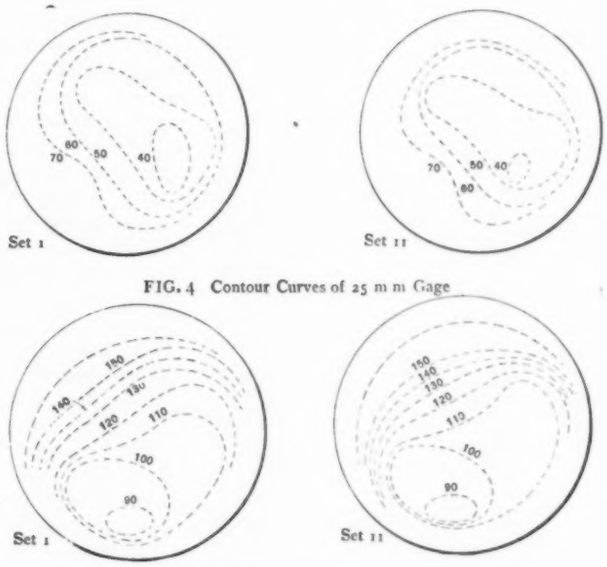


FIG. 4 Contour Curves of 25 m m Gage

FIG. 5. CONTOUR CURVES OF 150 M M. GAGE.

should have a true rotational motion, without any periodic to-and-fro translation along its axis, such as occurs with the usual coned or flat bearings. Subsequent calibration of the screw shows how nearly this ideal has been approached. Fixed to the nut N is a graduated wheel Q, and a double vernier g is shown attached to the casting R. The wheel is centered true with the nut axis by means of the double vernier in the usual way. The casting R has a front part T, to which an upright plate U is screwed. This plate carries the bearing E_1, the bracket V on which

for accuracy that the nut have no translation and that the screw have no rotation. The former condition should be achieved by the cone end method of working; the latter, by making the yoke and bracket rigid and insuring by a weight that the former presses the latter with constant force. Backlash and looseness between micrometer screw and nut are minimized by the pull of wights t_1 and t_2, Fig. 3, from which pulley strings pass over pulleys r_1 and r_2 to the yoke ends. By this means the screw is pulled back into the nut by a steady force.

clamped, so as to take up slack in the pulley-cord.

The two micrometer screws and nuts were cut and ground with great care on the plan adopted by H. A. Rowland, and when examined under the microscope the screws appeared highly polished and regular. The calibration, described below, shows that there is a small periodic movement at each rotation of the nut, probably due to its bearings being eccentric with respect to its axis. But this movement is perpendicular to the line of measurement, and the resultant errors in the

micrometry are of a lower order, and probably negligible.

The screw threads are about 2 in., and the nuts about 4 in. long, so that the screws do not leave the massive nuts at any point in the run. Steadiness in temperature of the screw is thus obtained. The screw diameter is 1 centimeter, the pitch ½ millimeter, the graduated head has 500 divisions, and the vernier reads tenths; so one vernier division corresponds to 1/10,000 millimeter (or 0.1 μ) in the micrometry. The bed is 5 ft. long, and weighs 200 lb.; it rests on three studs, two 1 ft. apart under one neutral line, and one under the other neutral line. A voltaic circuit, consisting of a cell C_1, a resistance-box R_1, switch x, and a telephone T_1, are joined to a binding screw l_1 on the bed, and to another binding screw l_2 on each headstock. The switch is put to right or left, according as one wishes to make contact between the gage and the left screw, or between the gage and the right screw.

The micrometer microscope Mi rigidly mounted on the right headstock, Fig. 2, is used for reading the standard invar scale S_2. By this means, as in the Pratt & Whitney measuring-machine, the end standards may be compared with line standards of length.

MATERIALS USED.

The bed is of cast iron. Most of each headstock is of cast iron, in one piece, but the front plates and brackets and the base-plates of the headstocks and table are of wrought iron. Brass is used for the nut bearings and for most of the table. The micrometer screws are of silver steel, and the micrometer nuts of bell metal, which is very hard. The part of the screw spindle projecting from the front of the nut is of first-grade invar. All caps and fittings on the screw ends are also of invar. Since invar cannot be ground very true, the faces of the caps are of thin steel. The idea is that these projecting parts, being of small dimensions and necessarily uncovered, are more liable to temperature changes. The consequent errors in the micrometry are small, since the expansibility of invar is so minute. The terminal points of the screw spindle are beads of iridio-platinum, which, being hard and non-oxidizable, is the best substance for electric-contact work. The beads are continuous, with a short piece of iridio-platinum wire, which was hammered into a hole drilled in the end of the invar.

APPLICATIONS AND RESULTS.

The method of connecting the electric circuit differs according to the object to be tested.

1. *Bar-Gages with Flat Ends*—These are measured between two points. The gage is put on the table and clamped. It must first be set so as to have one face normal to a screw axis by adjusting the table.

As will be seen from the contour curves following, the flat ends are never true planes, but for the above purpose the gage is taken to be set when the contact readings on all points on a circle near the edge of the face are identical.

The flat faces are roughly 6 millimeters across, the left screw point is brought into electric touch with the gage at the center of the left face, marked 1 in column *A*, Tables 1 and 2. The right screw point is then brought up to touch the right face, the circuit being now arranged to pass from the left screw through the gage to the right screw. The two micrometers are read as in columns *B* and *C*. Then the table, and the gage with it, is moved 1 millimeter to the left; the contact is now made at place 2 in column *A*. The micrometer-head readings are taken and entered in columns *B* and *C*, as before. The whole face, except near the edge, is thus tested in thirteen symmetrical places.

Results follow for two new gages, made by the best firms, in Tables 1 and 2. The numbers in columns *B* and *C*, and in other tables below, are those read on the micrometer heads, so that they give only comparative values from place to place, and would have to be all changed alike to represent the absolute values of the length of the gage. Column *D* is the sum of columns *B* and *C*; the larger the sum the less is the thickness of the gage on the line in question. The small disagreement between the results for the two sets is shown in column △. The gage is well covered throughout the readings. For the 25-millimeter gage, Table 1, the errors arising for any one position lie between 0 and 0.4 μ. These errors can be attributed mostly to bad polish of the surfaces. Grooves are visible, and small changes in setting the surfaces would bring the measuring point now over a ridge, now over a hollow.

The errors in reading the micrometer can be ignored, for if any observation be repeated before the gage be moved, the difference in the reading never amounts to more than 0.1 μ, generally less. Thermal expansion may produce a small deformation, since about three-quarters of an hour elapses between a reading in Set i, and the corresponding one in Set ii.

The differences in the gage thickness in different places amount to 3.6 μ. To show the nature of the gage, contour figures are drawn, one for each set. These curves are not contours for one surface in the usual way, but represent the joint effect of the two end faces of the gage.

In the 150-millimeter gage differences are slightly more, —0.1 μ to —0.5 μ (thermal expansion exercises more influence for long gages), than for the 25-millimeter gage. But differences in the gage thickness from place to place amount to 5.8 μ. The contour figures are given. The faces are not normal to the length of the gage, and no readings can be taken at places 5, 9; when in these positions one screw end touches the gage, the other screw end does not make contact on the other face, but, if continued, would meet the gage on its side. The actual length of this gage was found to be, at 18.5 deg. C., 150.0332 millimeters and 150.0325 millimeters in two distinct evaluations, taken at place 1, Table 2.

2. *Cylindrical Gages*—These are measured between lines or edges. The screw ends have cylinders or edges mounted perpendicular to the screw axes. A preferable method is to work between the screw points and to move the table carrying the gage up and down past the screw points so as just to establish electric touch in passing. In this way the straight lines mentioned above are virtual lines due to the passage of the measuring-points past the gage.

A.	Set i.			Set ii.			Δ = D′ − D.
	B.	C.	D = B + C.	B′.	C′.	D′ = B′ + C′	
1	116.5	147.9	264.4	117.6	146.9	264.5	+0.1
2	117.5	146.3	263.8	117.4	146.7	264.1	+0.3
3	117.3	146.9	264.2	118.2	146.3	264.5	+0.3
4	117.9	147.7	265.6	118.7	146.9	265.6	0.0
5	117	149.9	266.9	118	148.9	266.9	0.0
6	117	147.4	264.4	117.5	147.1	264.6	+0.2
7	117.8	147.6	265.4	118.4	147.3	265.7	+0.2
8	116.6	147.5	264.1	117.9	146.6	264.5	+0.4
9	118	147.5	265.5	118.1	147.7	265.8	+0.3
10	118	147.5	265.5	117.7	147.9	265.6	+0.1
11	117.7	146	263.7	117.3	146.6	263.9	+0.2
12	118.9	148.5	267.4	119.5	147.9	267.4	0.0
13	119	147.5	266.5	119.6	147.1	266.7	+0.2

TABLE 1. 25-MILLIMETER GAGE.

1	395	96.2	491.2	395	96	491	—0.2
2	397	93.8	490.8	396	94.5	490.5	—0.3
3	396	94.9	490.9	395	95.5	490.5	—0.4
4	398.7	93.5	492.2	396	93.9	491.9	—0.3
5							
6	394	88.7	492.7	396	96.6	492.6	—0.1
7	396	95.5	491.5	396	95.0	491	—0.5
8	398.3	96.7	495	399	95.5	494.5	—0.5
9							
10	396	93.7	489.7	396	93.4	489.4	—0.3
11	397	93.4	490.4	397.5	92.8	490.3	—0.1
12	398	91.7	489.7	399	90.5	489.5	—0.2
13	396	92.9	488.9	396	92.7	488.7	—0.2

TABLE 2. 150 MILLIMETER GAGE. THE UNITS ARE MICRONS.

—	Centimetres from End.	Set i.			Set ii.			Δ = D′ − D.
		A.	B.	D = A + B.	A′.	B′.	D′ = A′ + B′.	
deg. 0	0.5	236.9	197.8	434.7	238.5	201 2	434.7	0.0
	1.0	242.0	192.6	434 6	238.0	196.7	434.7	+ 0.1
	1.5	241.1	193.5	434.6	238.0	196.7	434.7	+ 0.1
	2.0	234.4	199.8	434.2	231.0	203.1	434.1	- 0.1
	2.5	226.6	207.6	434.2	223.0	211.2	434.2	0.0
	3.0	235.3	199.0	434.3	231.0	204.2	434.2	- 0.1
45	0.5	237.6	197.0	434.6	231.0	203.6	434.6	0.0
	1.0	243.0	191.7	434.7	238.0	196.5	434.5	- 0.2
	1.5	241.0	193.4	434.4	236.5	197.8	434.3	- 0.1
	2.0	234.0	200.2	434.2	230.0	204.0	434.0	- 0.2
	2.5	226.0	208.3	434.3	223.0	211.2	434.2	- 0.1
	3.0	233.0	201.3	434.3	230.0	204.1	434.1	- 0.2
90	0.5	234.0	200.6	434.6	230.0	204.6	434.6	0.0
	1.0	240.0	294.4	431.4	236.0	198.5	434.5	+ 0.1
	1.5	240 0	194.3	434.3	237.0	197.5	434.5	+ 0.2
	2.0	233.5	200.8	434.3	230.0	204.2	434.2	- 0.1
	2.5	225.0	209.1	434.1	223.0	211.2	434.2	+ 0.1
	3.0	233.0	201.1	434.1	229.0	206.2	434.2	+ 0.1
135	0.5	234.0	200.5	434.5	231.0	203.4	434.4	- 0.1
	1.0	240.0	194.6	434.6	238.0	196.5	434.5	- 0.1
	1.5	240.0	194.3	434.3	236.0	198.3	434.3	0.0
	2.0	233.0	201.0	434.0	229.0	205.2	434.2	+ 0.1
	2.5	225.0	209.2	434.2	221.0	213.3	434.3	+ 0.1
	3.0	234.0	200.3	434 3	229.0	205.2	434.2	- 0.1
180	0.5	235.0	199.7	434.7	225.0	202.6	434.6	- 0.1
	1.0	237.8	196.8	434.6	238.0	196.5	434.5	- 0.1
	1.5	239.0	195.4	434.4	238.0	196.4	434.4	0.0
	2.0	232.0	202 1	434.1	230.0	204.2	434.2	+ 0.1
	2.5	224.0	201.2	434.2	222.0	202.2	434.2	0.0
	3.0	232.0	202.2	434.2	230.0	204.2	434.2	0.0

TABLE 3. ¾-INCH CYLINDRICAL GAGE. THE UNITS ARE MICRONS.

Before commencing measurement the axis of the gage is set perpendicular to the screw axes. Put the gage on the table, its axis being horizontal and across the length of the bed; take a contact between the left screw end and one end of the

gage. Move the gage by the table till its other end makes contact with the left screw end. If the two contacts have identical micrometer readings, the gage is set.

The results for a ¾-in. gage are shown in Table 3.

Readings are made along the gage at six places from 0.5 to 3 centimeters from one end. After one set of six readings the gage is rotated on its axis to positions 45 deg., 90 deg., 135 deg., and 180 deg. from the original one, and for each position six readings are taken, as before.

Set i takes about three-quarters of an hour, and is completed before Set. ii is commenced; corresponding measurements are in one line. In no case do the results of the two sets differ by more than ± 0.2 μ.

The gage is a very good one; the differences in various places are not more than 0.7 μ, though there is a distinct tapering in every position, the handle end being thickest. There is a slightly different angle of taper in the different positions. The 180-deg. position results are almost identical with those for the 0-deg. position, as they ought to be.

"Babbitt" Metal.

BY. JOHN F. BUCHANAN.

Isaac Babbitt was born at Taunton, Mass., July 26, 1799, and died May 26, 1862. He served an apprenticeship to the goldsmiths' trade, and early became interested in the production of alloys. In 1824 he manufactured the first britannia ware in the United States. In 1839 he discovered the well known anti-friction metal, for which the Massachusetts Charitable Mechanics' Association awarded him a gold medal, and Congress subsequently voted him a pension. Many people have hazy notions of Babbitt, babbitt metal, and babbitting.

Babbitting, or the lining or interspacing of bearings with anti-attrition metal, has done more to increase the speed and economy of modern machinery than any other single process or practice in engineering. But if Babbitt could only return he would repudiate many of the metallic miscellanies hawked and passed on the unsuspecting as babbitt metal. Remember, Babbitt manufactured britannia ware, and britannia metal is an alloy of tin hardened by antimony and copper. Babbitt's metal, therefore, was purely and simply a britannia metal, and when he had finished with the making of it, it consisted of: Tin, 88.9 per cent.; antimony, 7.4 per cent.; and copper 3.7 per cent. The figures give us no information about the method of combining the metals, and that is the most important thing in the production of alloys intended to undergo mechanical treatment. The improvements in the modern bronzes are as much due to correct methods of combining the metals as to the introduction of new elements. It is recognized nowadays that the mere melting and mixing of metals together, regardless of their chemical qualities, does not conduce to the highest excellence in the combination. The direct melting of the metals to produce an alloy of more than two metals is a crude process, wrong in principle and generally unsatisfactory in the final result. The uses of "hardening," remelting, "temper," and fluxes must be understood in order to get the best results from babbitt metal. Even the order in which the metals are melted and blended is of some importance. The proper course is always to make a "hardening" for alloys of metals showing disparity in fusibility and specific gravity. Babbitt's "hardening" was made by melting copper 4, then adding gradually tin 12, antimony 8, and finally a further addition of tin 12. To make the "lining" metal 72 parts of tin were melted and the 36 parts of "hardening" dissolved therein, so that the alloy was made at a low temperature—practically at the heat of melted tin. Overheating is a fruitful cause of dissatisfaction with the wearing and working qualities of anti-friction metals. The effect of high temperatures on metals of low fusibility is always harmful, more especially if the metals have a tendency to crystallize. In cooling, the refractory combinations (copper, antimony, tin) set first, leaving the more fusible combinations (tin, antimony, copper) to solidify on the surface. That is why in the directions for using genuine babbitt metal we are told to cast the working face of the bearing downwards, if possible, and to avoid high temperatures and slow cooling. The latter conditions produce bigger crystals and a greater separation of the constituents in the alloy, weakening its cohesive force and increasing the coefficient of friction.

The properties which make babbitt metal so valuable are its power of accommodating itself to a hard unyielding surface, its capacity for taking a polish, its power of resisting certain chemical influences, and its low melting point. Genuine babbitt metal will not cut, scratch, or heat the journal, and after being in use for some time the bearing takes a glittering appearance on the surface. But all that glitters is not babbitt! The variations in the genuine babbitt metal are limited, but the commercial grades sold for babbitt metal are endless, and prices sometimes prove that tin is barred as a luxury. During the years of my apprenticeship Babbitt's patent metal was the only thing available for lining bearings, etc., but in 20 years many changes are possible. It was found that babbitt alloy was greatly improved as a self-lubricating metal for fast-running light machines, when a portion of the tin was replaced by lead. Further experience brought out the truth that properly hardened lead was equal to hardened tin as a metal for anti-friction purposes. 'Twas then the flood arrived! For some years it rained anti-friction metals. They were registered under all sorts of fancy titles.

Now, if you should happen to want the best babbitt or anti-friction metal that can be made, make it yourself thus: Select the purest metals that can be had, and the most suitable recipe for the duty of the alloy; make a preliminary mix of the refractories in a plumbago crucible, and pour it out for "hardening." Melt the metal which forms the basis of the alloy (it may be tin, lead, or zinc), and dissolve the hardening therein, at a gentle heat, using sawdust, tallow, or powdered sal-ammoniac for a flux. For making a large quantity in the ordinary brass furnace, make a cast-iron crucible 2 inches smaller than the diameter of the furnace; lower it into the furnace and lute round. One word of caution is needed here. Zinc should not be melted in an iron pot, but if melted in a plumbago crucible it may be poured and mixed with the other components of the alloy already melted in the pot.

The utility of babbitt metal is not to be gaged by its cost per pound. A cheap babbitt (lead or zinc base), well made, may give better service than a costly mixture which has been carelessly blended. Besides, the commercial grading of metals by number or title is like the private marks of retail merchants—unintelligible to the outsider. Generally the grades are for: 1, light loads and high speeds; 2, medium loads and moderate speeds; 3, heavy loads and slow or moderate speeds; and 4, heavy loads and high speeds. Such grading is reasonable, for the hardness of the alloys increases with the numbers, and price does not count. The time for selling alloys by analysis is not yet, but it is bound to come.

To sum up, babbitt metal is essentially a tin alloy, but modern engineering practice and commercial usage favor the continuance of the name to all metals capable of the same duty as babbitt. Hence we get three series of babbitt or anti-friction metals: 1st, the tin series; 2nd, the lead series; 3rd, the zinc series. Tin is the most polishable of the soft metals, and it alloys readily with any of the useful metals employed for minimizing the friction of machinery; it has been made the basis of the best anti-friction alloys. Lead is undoubtedly the best anti-friction medium among metals, but it wants a great deal of stiffness to stand up to the work. Copper is the ideal bond for zinc alloys, and zinc is the most expansible and durable of metals. Zinc babbitts cast well, wear well, and fit snugly to the bearing. Owing to its highly crystalline structure, antimony, the principal hardening element, should not exceed 20 per cent., as it is apt to separate and rub out of the alloy—17 per cent. has been fixed as the limit by an eminent authority.

The mutual relations of the metals

determine the mechanical properties of the alloys. Zinc and antimony are too much alike to be used simultaneously, and tin alloys, without copper, are apt to spread under heavy loads. Due to its poor affinity for lead and tin and its low atomic volume, aluminum is not a suitable metal for anti-friction alloys. Bismuth, on the contrary, is a decided advantage up to about 1.5 per cent. This metal has been freely used in the production of some modern alloys, notably those with low fusibility, low contraction and high atomic volume. In Table 1 are given some special mixtures which have given complete satisfaction for the duty stated.

For Lining.	Tin.	Lead.	Zinc.	Anti'ony.	Copper.	Bismuth.
Dynamos : High-speed	88	.....	.....	8	3.5	0.5
Marine engines	77	17	.....	3	3	.....
Eccentrics	5	78	.....	15	2	0.25
Submerged bearings	40	48	.....	10	2	.....
Main bearings	34	44	.....	16	6	.....
Slides, thrusts	63	.....	30	2.5	2.5	.....
Railway trucks	41	.....	56	.....	2	.....
Axle-boxes (by analysis)	74.22	13.50	1.80	6.55	3.60	.....
Anti-acid metal (by analysis)	78 84	14.75	.....	trace	3.70	.....
Plastic metal	80	10	.....	1	8	1
Genuine babbitt (hard)	80	.....	.....	10	10	.....
" " (No. 2)	83	.....	.....	9	8	.....
Universal bearing metal	6	78	.....	16	.....	0.25
Anti-friction castings	24	.....	80	.....	4	.....

TABLE 1. MISCELLANEOUS BEARING METALS.

Grades.	1	2	3	4
Tin	77	77	17	....
Zinc	....	17	77	77
Lead	17	7	7	17
Antimony	7	....	....	6
Copper	6	6	6	7

TABLE 2 A MANUFACTURER S MIXTURES.

Lastly, we have the mixtures of a manufacturer representing four grades, as given in Table 2.

In each case the metals represented by the figures 7, 17, and 6 constitute the "hardening." These are what are termed copper-hardened alloys—the copper content being over 5 per cent. This series is worthy the attention of all who are seeking for cheap, serviceable, anti-friction metals.—*The Foundry.*

A report is in preparation by the United States Geological Survey regarding "Magnetic Wells," by which are meant wells the casings of which attract and hold iron objects, ordinarily small articles such as nails, but sometimes there is sufficient magnetism to hold hammers or wrenches. Reports have been made of wells, the water from which has been described as magnetic. The method of making a test for magnetism in water is described as follows: A glass vessel should be filled at the well and carried to a distance of about 100 paces from the well and also from any mass of iron. A piece of steel, such as a pocket knife, should then be carefully tested with some common needles for magnetism and if found not magnetized should then be placed in the water in the glass vessel and allowed to remain there for five minutes, after which it should be wiped dry and again tested for magnetism. If these reports are true, we wonder if this has anything to do with the art of the water finder.

Motor Car Cylinder Founding—I.

BY HUGH DOLNAR.

Motor cars, mechanically self-propelled on common roads, began their existence more than a hundred years ago, before the steam locomotive was proposed for railways, but did not attract close attention for a century or so. They began to be studied by a number of investigators and constructors about 1890. Interest in the motor car has advanced in geometric ratio from then to now, and at this time the motor car is the most eagerly followed mechanical problem of civilization.

The horse is the cause of all the dirt, and much of the noise and street repairs of cities, and must be displaced by mechanical traction as soon as possible. Motor-car riding for pleasure and for time saving is of the highest value, and these conditions of horse service and mechanical traction make the perfecting of the motor car the most important present mechanical problem of civilization.

The small gas engine is the principal motive element for car driving on streets and common roads. Storage batteries and electric motors have their place in certain forms of cars, and steam engines yet find determined advocates, but the gas engine is far in the lead, and is now in a fair way to find extensive use on railroads also.

All of this makes every detail of small gas-engine construction highly important to a very large class of mechanics, and gives great interest to practical details of large producers of car motors and car-motor components.

It was at first supposed that wrought steel, in the form of drawn-steel tubes, was the most suitable for small gas-engine cylinders, but gray-iron castings may be said to be now used exclusively for this principal member of the small gas engine, and a fairly complete showing of motor-car cylinder-founding practice, and of the precise constitution of the irons used, which it is proposed to give in several wholly disconnected stories from different foundries and laboratories will, beyond doubt, interest many mechanics.

Small gas-engine cylinders vary greatly in form and construction, as they are yet both water and air cooled, and the water-cooled cylinders are made with applied heads, applied water jackets and applied valve seats, or integral, cylinder, head, water jacket and valve seats all in one complicated casting, or in all possible combinations of integral and applied cylinder members, while the air-cooled cylinders show an almost equal variety of construction forms, the radiating members, heads and valve seats being either integral or applied, according to the fancy of the designer, and the radiating members being often made of material other than gray or cast iron.

A single, water-cooled, small, gas-engine cylinder, with head, valve seats and short intake and exhaust pipes, all formed in one integral gray-iron casting, looks like about the practicable limit of founding complexity; but at this moment the "dual-unit" cylinder, two of these highly intricate structures cast in one integral piece, and calling for great care and skill on the part of the foundry superintendent, the pattern-maker, the core-maker, the molder and the core-setter, is regarded with great favor, and the foundry labor sub-division is carried to such an extent that 12 or 15 separate workmen may have important parts in the production of a small cylinder.

As the practical molder will readily guess, these cylinder patterns are parted variously; the flasks are parted to suit the patterns, and the position of the cylinder in the mold and the manner of gating and pouring, as well as the mixture of irons used for cupola or furnace charging, are varied to suit the convictions of the designer, the molder, the melter, and in short of all concerned in the production of these widely differing cylinders, so that no two forms of cylinders are made by the same methods and the practice of no two foundries making these cylinders is the same.

The first illustrations given are from the Reedy foundry, 83-91 Illinois street, Chicago, Illinois. This foundry makes a large variety of moderately heavy and light castings, and is in charge of a foundry foreman of long experience, who depends very little on the chemist, and very largely on himself and the wide range of work he has handled successfully without other guide than the operations on his own foundry floor, and the quality of the castings he has produced speaks for itself.

A very large proportion of the cylinders made are poured from iron melted in the cupola. At least one cylinder founder is, however, melting cylinder iron with the air, or reverberatory furnace, in which no free oxygen is expected to meet the furnace charge, which is consequently supposed to enter the cylinder mold as it was placed on the hearth, unchanged by the operation of melting. The Reedy foundry melts with the cupola, expecting to avoid hurtful changes of the charge in melting by care and skill in cupola tend-

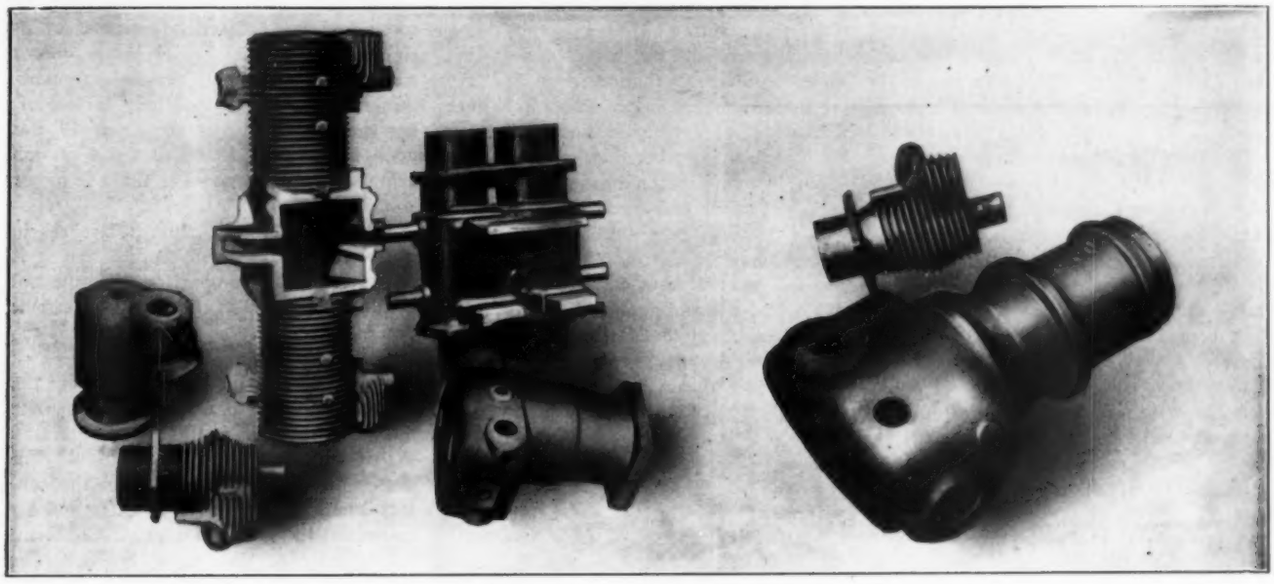


FIG. 1.

FIG. 2.

FIG. 3.

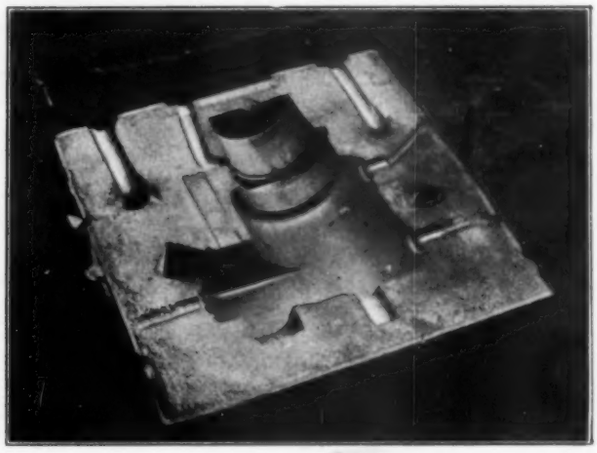


FIG. 4.

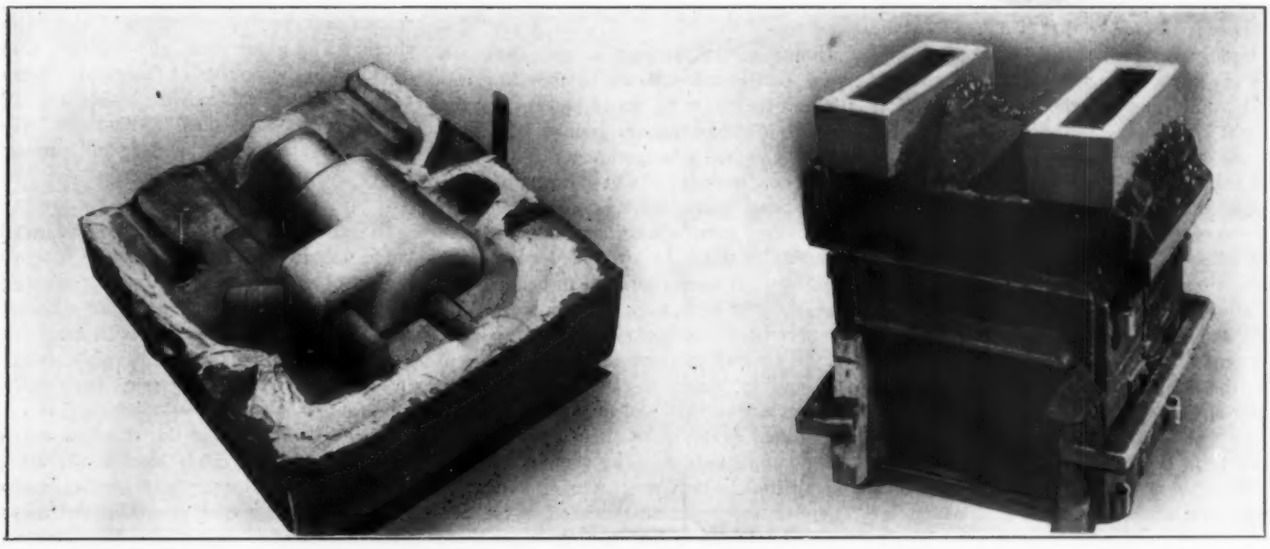


FIG. 5.

FIG. 6.

PRODUCTS AND METHODS OF THE FERRO FOUNDRY.

ing, and pointing to the uniformly satisfactory character of its cylinder castings as proof that this expectation is realized, and that in proper hands the cupola is thoroughly good form of iron-melting agent.

The Reedy cylinder molding is wholly directed by the foundry superintendent, who has strong convictions as to what should be done to produce the best castings for gas-engine cylinders. In brief, the Reedy practice is to bake the cylinder molds, made of course in iron flasks, in the core oven until entirely dry, the Continental cylinder, from which the illustrations given were taken, being made from a pattern divided lengthwise, in a two-part flask with horizontal parting during molding, mold baking and core setting. After the cores are set the mold is clamped, turned up on end so as to place the cylinder head at the bottom of the mold, and the mold then has a false cheek or top extension applied. On top of the false cheek the runner and riser boxes of gray iron lined with dry sand are placed, the runner leading down to the bottom of the cylinder mold, where the iron enters, and rises to the top end of the casting, which is the flanged lower end of the cylinder in the finished engine. All sand and dirt float on top of the molten iron as it rises in the mold, and find a final exit in the riser.

The object of the false cheek, or flask placed on the top of the mold, is to give hight or head to the runner and the riser, so as to cast the working part of the cylinder under a considerable head of melted iron, to increase the density of this hard worked and vital portion of the cylinder.

The superintendent explained that the top and bottom parts of a casting, as it lies in the mold, must differ sensibly in points of density, hardness, strength and wear resistance, and in expansion under application of heat to the finished cylinder. It is easy to believe that if one side of the cylinder was harder than the other and the cylinder was finished true, straight and round inside when cold, that heat might change the shape of the bore; but if one end of the cylinder was harder and different from the other end, so that opposite sides of the cylinder were the same at every point of its length, then there would seem to be less probability of one side elongating more than the other by heating, and so making the cylinder bore crooked when the engine was heated, in working, by the flame inside of it. These are the considerations which lead the superintendent of the Reedy foundry to believe that pouring the cylinder standing on end, head down, is of great importance.

It is well known that in finishing cylinders of some forms, considerable change of shape occurs soon after boring, and it is the practice with some gas-engine makers to make two cuts through the cylinder bore, then lay the cylinder aside for two weeks, and then re-chuck and finish it with a light boring out, reaming and grinding. It is asserted, also, that some cylinders do change form in working by unequal cooling of the sides, either with water or by the air blast. Whether these things are true or untrue, it seems better to found the cylinder so that whatever structural differences there may be in the cylinder walls shall vary from end to end rather than from side to side, and for this reason it is far better to pour the cylinder standing on end than lying on the side, and this is the view held by the Reedy foundry superintendent, who also believes that a high head in pouring makes better cylinders than a low head. As will be told in following stories of cylinder-founding practice, these opinions are not held by all foundry superintendents.

The Reedy practice of fully drying the molds by baking in the core oven insures a much closer approach to accuracy of core setting than where the cores have to be set in the fragile structure of a green-sand mold, or even in a mold which is skin-dried by the use of the gas torch. The Reedy cylinders average only 5 per cent. of loss from bad castings, which is very small indeed for such difficult work; in one foundry 40 per cent. of imperfect cylinder castings was for a time about the average. A dry-sand mold gives core-print resistance enough to permit the use of metal-tube core prints in the cylinder barrel core, and of course makes the core setting a much less delicate operation than where the mold is of green sand, easily displaced by a mere touch.

The cylinder walls may be ⅜ inch or more in thickness, but the water-jacket walls are always made as thin as possible to save weight, and are usually about ⅛ inch thick in the drawings of the cylinders. This thinness gives very little margin in the core setting and makes dry-sand molds much the more likely to produce perfect castings.

Some of the air-cooled cylinders are very costly and difficult in founding, although they have no water jackets and the coring is comparatively simple.

No conclusive experiments have been made to determine the best forms of cooling ribs or spines for air-cooled cylinders, and very great variations occur in the practice of different air-cooled gas-engine builders. It seems rational to believe that the thinner and deeper the integral circumferential cooling ribs of a cylinder are the more efficient radiators they will be, and in many instances the cooling flanges are so thin and deep and so closely spaced as to make them very difficult productions indeed. The same with cooling spines, which are often so long and slender, as shown on the head of the air-cooled cylinder in Fig. 3, as to make them difficult to produce. On the other hand, the cooling spines on the Frayer-Miller cylinders were gradually cut down in length to ¼ inch, with no reduction in cooling effect. In fact they seemed so insignificant that one Frayer-Miller motor was made with smooth-finished cylinders, thinking that the ¼ inch long little cooling spines could be of no use at all, but upon trial it was found that the smooth cylinders would not cool so that the motor could run.

There are yet very great differences in car motors in many directions, and it is only by extended comparison of forms and results obtained that the final best can be determined.

Referring to the illustrations, Figs. 1, 2 and 3 show cylinders supplied by the Reedy foundry. In Fig. 1 a pattern of a dual-unit is shown at the upper right, and a pair of large air-cooled opposed cylinders with integral crank box in the center; small single cylinders, water and air cooled, at the left, and a single Continental cylinder at the right below. The mold with and without the core of this Continental cylinder is shown in Figs. 4 and 5. Fig. 2 shows another view of the small air-cooled cylinder shown in Fig. 1 and the Silent Knight cylinder below. Fig. 3 shows an air-cooled cylinder at the left and a dual-unit at the right. Fig. 4 shows one part of a mold made and baked dry in the core oven, and set on the foundry floor, ready to have the cores set in it. Three of the four chaplets, for the core to rest on, are shown. This mold is hollow, though it is easy to make it appear convex. The light falls from the upper right-hand corner. Fig. 5 shows the same mold as Fig. 4, with the water-jacket core surrounding the cylinder-barrel core and both cores set in place in the mold, which has been smeared with thick flour and water paste, so that the two parts will close tightly together, and prevent the escape of the melted iron. Fig. 6 shows the flasks of the Continental cylinder clamped together and set on edge, and a false cheek set on top of them, with runner and riser boxes on top of the false cheek. The gates from the runner box go down to the bottom of the mold. These runner and riser boxes or basins are of cast iron, dry-sand lined. When the cylinder is poured, both the riser and runner boxes are full of melted iron.

In order to compare the cost of machine labor with hand labor, a careful record of all expenses incurred at several mines was secured. The result showed that the cost of mining coal with machine labor was 64 cents per ton, while hand mining amounted to 78.3 cents per ton.

In the United States the standard market commodity in crude steel is the 4-in. billet, although larger and smaller sizes are rolled. This size is considered most generally useful, and it can be rolled in combination rail and billet mills by changing the rolls. Abroad, a billet 2 in. square or smaller is used in the rod mills.

A Large Boring and Drilling Jig Used at the Works of the Landis Tool Company, and its Special Tools.

BY H. F. NOYES.

The half-tone, Fig. 1, and the drawings show the work to be a large, open box-shaped casting, with an offset portion, and a little study will convince anyone that it is not the easiest design in the world to bore and drill without a jig.

Various views of the work are illustrated in Fig. 2, of which the upper right-hand view is from the opposite side from which the photograph was taken. Fig. 3 shows plans and elevations of the jig, the front elevation being also from the opposite side from that shown in the half-tone. The rear end elevation is of the end shown in the half-tone as away from the boring machine.

The most essential requirements were that the holes *AA* and *BBB*, Fig. 2, be located in line, that *AA* be located the proper distance from *BBB*, and that the faces of the bosses to these holes be located accurately with relation to each other and to the casting. Only an average degree of accuracy was required for the other holes. The work is located and fastened to its place in the grinding machine by the L-shaped section *C*, Figs. 2 and 3, and therefore this was chosen as the proper locating section for the jig.

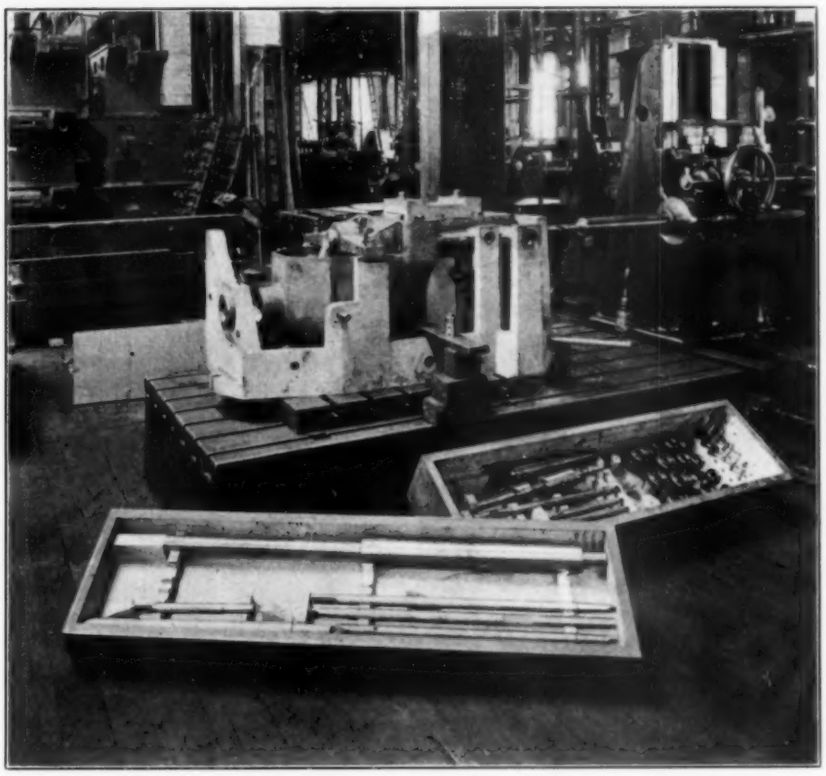


FIG. 1. THE WORK AND ITS JIG AND TOOLS.

With the idea of saving pattern work, the jig was designed to be cast without any cored work. Owing to its depth, this necessitated a sort of cathedral style of architecture, which is not wholly pleasing to the eye; but as it answers its purpose, and cost was saved, its appearance may perhaps be forgiven.

The work, after being planed, is lowered into the jig, lined up by the L-shaped section *C*, and fastened by the clamp *F*,

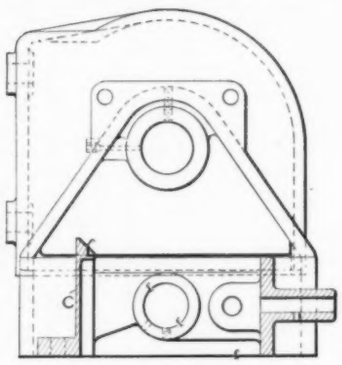


FIG. 4

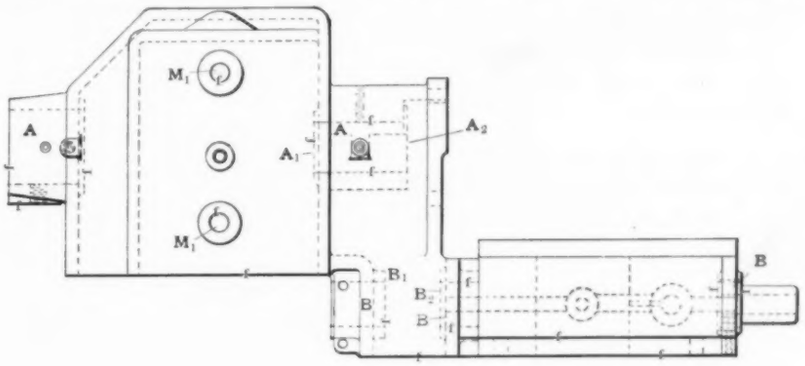


FIG. 2

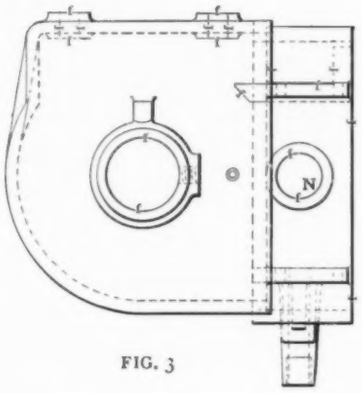


FIG. 3

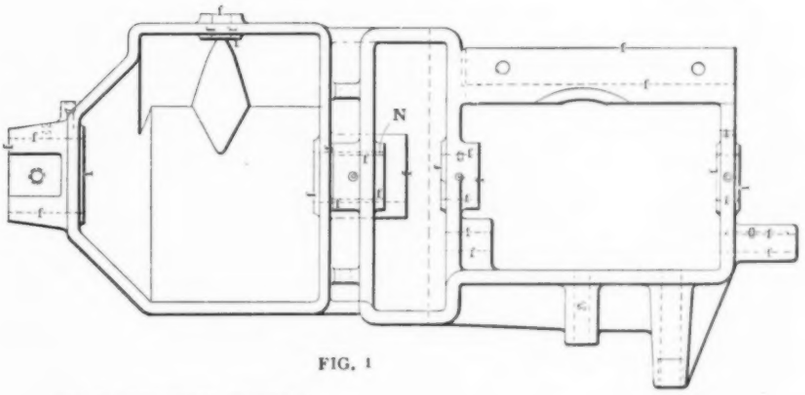


FIG. 1

FIG. 2. THE PIECE OF WORK.

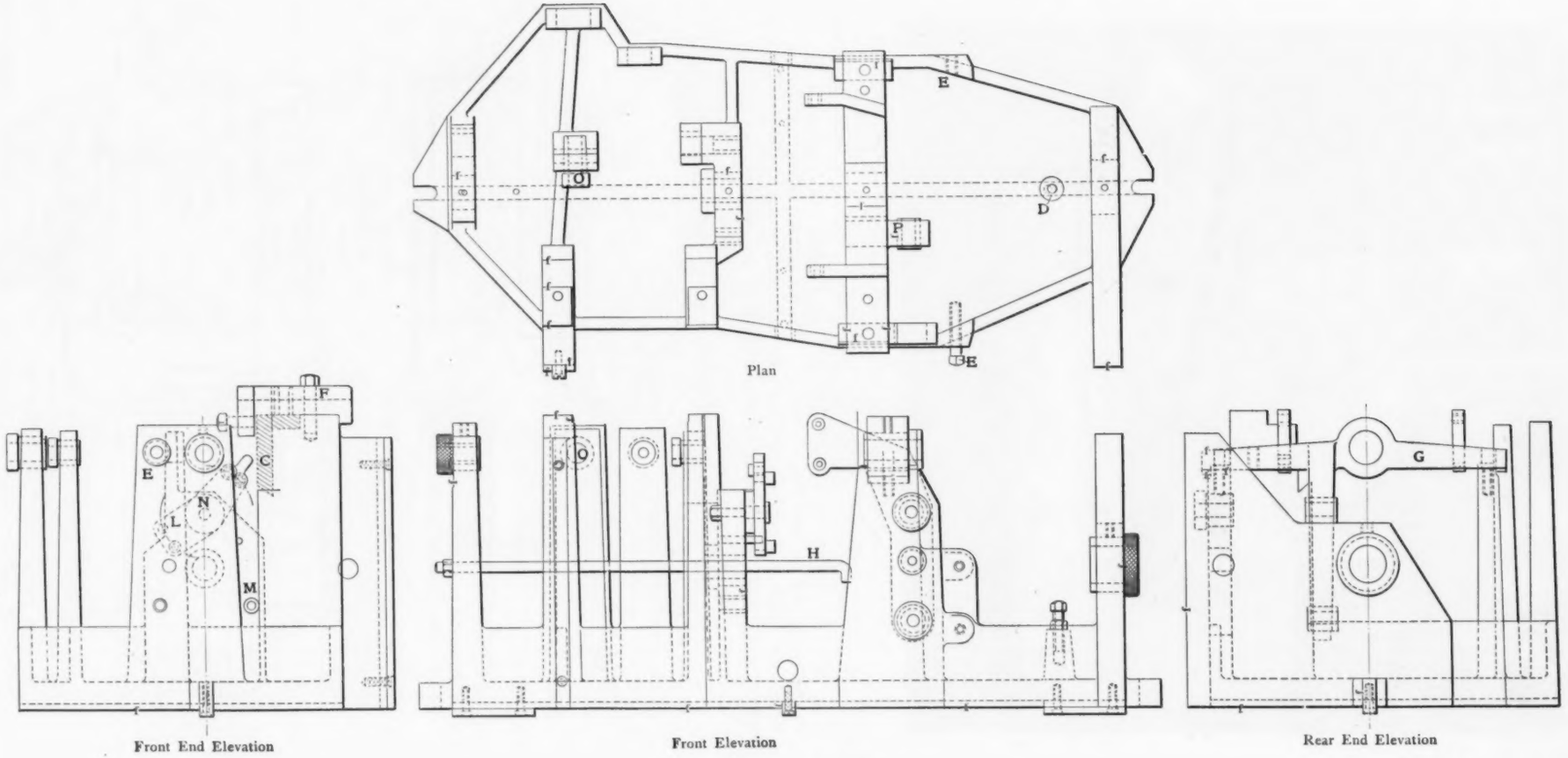


FIG. 3. THE JIG.

Fig. 3; it is further supported at the bottom by the set-screw *D*, and at the sides by the screws *F*.

At the top, the jig is strengthened, and held from springing by the heavy clamping-bar *G*, which is also provided with a bushing to guide the end of the boring bar.

To prevent any longitudinal working of the casting, a hooked rod *H* is provided, which serves to bind it firmly against the end of the jig casting.

For boring the holes *AA*, one of which is 3, and the other 2¾ inches in diameter, Fig. 4, the bar *I* is provided, having two sets of cutters, each set comprising a first and second rougher, a finishing cutter, and a right- and left-hand facer. We usualy allow about 1/16 inch for each of the roughing cutters to take off, and about 0.012 for the finishing cutter. It is the practice to fasten these cutters in the bar with a cone-pointed set-screw; the cutters are then accurately ground to the required diameter of hole, and suitably relieved for clearance.

When using this bar the outer end of the jig, as shown in the photograph, is turned toward the boring machine.

For boring the holes *BBB*, the bar *J* is supplied, this being furnished with similar sets of cutters. The outer of these holes is to be tapped, and for this the bar *J* is removed and replaced by the arbor *K*, which is provided with a shell tap fitting its end.

for facing the inside bosses A_1 A_2 and B_1 B_2 to the desired dimensions, a gage *L*, Fig. 5, shown also in position in Fig. 3, is provided, having hardened-steel distance pins, and pivoted at such a point that the proper pin can be readily swung into position to gage its respective face; while all can be readily swung out of the way of the bar, the long hooked pin being designed to reach the face of the boss A_1. By means of these gages the relation of the faces with respect to each other, and to the casting, can be always maintained.

For facing both sides of the holes *M*, Fig. 2, the arbor *M*, Fig. 4, is designed, provided with positive stops. The detail of the arbor shows one of the cutters backed against a bushing *N* of the jig. This gives the proper depth of cut for the other cutter, and to locate the first cutter

a stop is provided on the end of the arbor.

For drilling and reaming the remaining holes, the usual forms of drills and reamers are provided, using removable bushings wherever necessary. It is the usual practice to make the bushings for boring bars of cast iron, and for drills of tool steel hardened.

As shown in the half-tone, all the special tools required for this job are kept together in boxes made specially for the purpose, the boxes as well as all the tools being stamped with the name and symbol number of the piece for which they are to be used.

The jig as first drawn up was made to use on the table as shown, being properly located in line with the boring machine by keys in its base. This involved considerable trouble in changing from end to end, requiring a separate reclamping of the jig each time. Recently this has been remedied by providing a swiveling table, which can be readily located at four right-angled positions, thus doing away with the necessity of reclamping the jig.

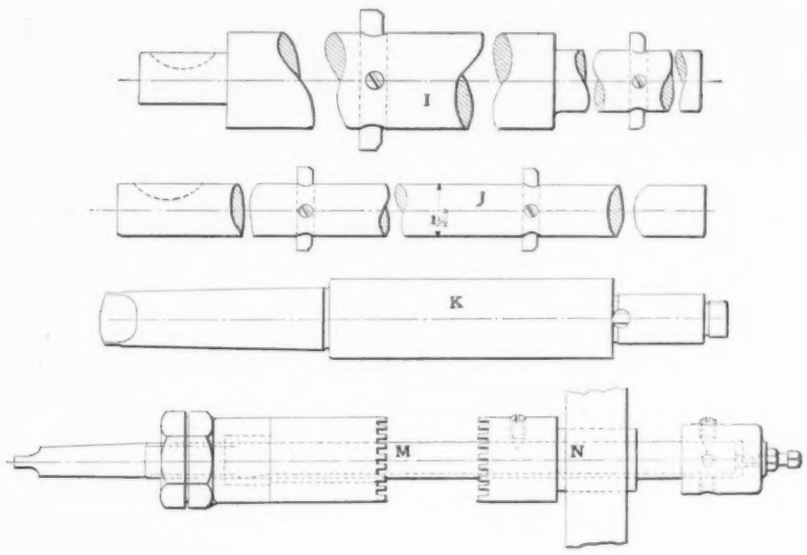


FIG. 4. BORING BARS.

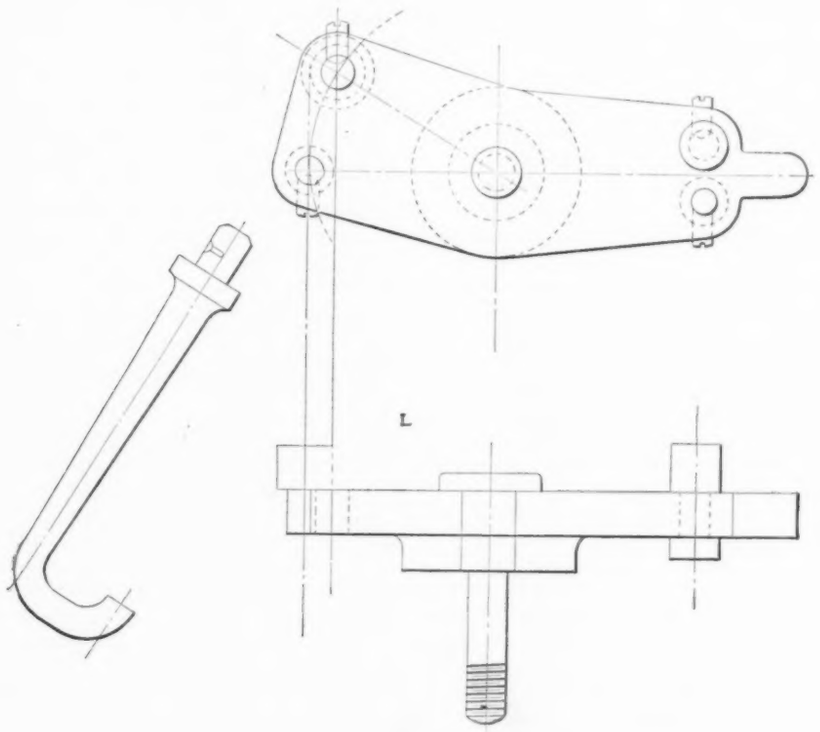


FIG. 5. FACING GAGE.

Value of Anthracite Lands.

The town of Pottsville in Pennsylvania is preparing to celebrate the one-hundredth anniversary of its foundation, which was practically coincident with the beginning of the anthracite coal trade. The town owes all its growth and present importance to that trade. It is the center of the southern anthracite field, which was for a long time the only part of the region worked. The first discovery of coal on Sharp mountain dates back to 1791, but it was not until 1806 that Thomas P. Ridgway found coal in the Mahanoy valley, and succeeded in interesting Stephen Girard in his discovery.

An interesting point, however, is found in the price of coal lands at different times. Girard and others, in the early days, bought land at $5 and $10 an acre. Two, at least, of the older anthracite companies—one of them the Lehigh Coal and Navigation—bought their original holdings at such prices, and values did not advance much until after 1830. In the speculative period which preceded the panic of 1837 anthracite lands advanced rapidly, and fully $5,000,000—a great sum for those days—was invested in less than than a year. Toward 1850 about $100 an acre became an established price, and there was little variation from this for about 20 years. When the Reading Company, under Franklin B. Gowen, decided that the ownership of coal was essential to the continued prosperity of the railroad, prices made a rapid advance. A large part of the Reading holdings cost from $200 to $300 an acre; and when other companies followed this example, as high as $500 was paid, $1000 being reached for one specially desirable property.

This was thought at the time, about 1890, to be the limit, but prices have gone far beyond that. The sale of the Pennsylvania Coal Company to the Erie six years ago was the transfer of a developed property and its equipment, so that it is difficult to work out the land price; and the same may be said of the purchase of Coxe Brothers & Company by the Lehigh Valley last year. During the last six months, however, there have been considerable purchases of undeveloped lands; the Schuylkill Coal Company and others have paid from $2000 to $3000 an acre. Very few tracts remain which are not controlled by the large carrying companies, and the owners are holding these, believing they can realize $5000 an acre.

Probably no other coal lands in the world carry so high a present value. The extent of the anthracite fields of the country is pretty well known; and so is the area of land still unsold, which is very small in extent.

The foregoing, which we take from our contemporary, *Engineering and Mining Journal*, illustrates very clearly the essential difference between things which

are sometimes mistakenly called monopolies and those which are real monopolies. During the years when these coal lands have been increasing in value the owners of them have been deriving an income from them probably at least equal to average manufacturing profits.

The figures given represent nothing but the growing value of the privilege of standing at the doorway to nature's storehouse and saying what shall be paid by the rest of us who must make use of the stores therein. In the impending economic changes it is to be hoped that manufacturers generally, whether incorporated or not, will not only perceive that they have no such monopoly privileges, but will not hesitate to make it clear to others that they have not. On the contrary, though a manufacturer may be also a monopolist, just as his employee may be, the manufacturer and his employee as such, both are robbed of a portion of what they earn by such monopolies.

Worm Gear Design.

BY ROBERT A. BRUCE.

In an article by A. M. Sosa on Worm Gear Design, published at page 708, he explains that his object is to present a formula for determining the pitch and lead of a worm and leave it open for criticism. In view of the interests involved and owing to the fact that my own examination of the question has led me to very different and in some cases directly conflicting conclusions I avail myself of the opportunity for criticism.

I will first state the conclusions I have arrived at as briefly as possible.

(1) Granted that the requirements of strength have been satisfied, increased pitch is unavailing, since increase of pitch is not attended by material increase of contact surface and consequently is not accompanied by power to sustain a greater limiting thrust. In other words the limiting end thrust is independent of the pitch—apart from strength considerations.

This is in direct conflict with Mr. Sosa's contention that W varies as p.

(2) Assuming that all worm wheels subtend in cross section an equal angle at the worm center, the limiting thrust W varies directly with the diameter of worm d.

This agrees with Mr. Sosa's formula.

(3) As far as the limiting end thrust alone is concerned (but not as regards the power transmitted) differences in the angle of thread have very slight influence and may be disregarded.

This is at variance with Mr. Sosa's conclusions.

(4) The relationship between rubbing velocity and pressure is complex, and appears to depend more upon the nature, quantity, temperature conditions and mode of application of the lubricant than upon the materials of the opposed surfaces. The best experiments known to me indicate some such law as $Wv^n =$ constant for a given worm, run under varying loads at different speeds. The value of n may be 0.5 to 0.3 and may possibly greatly transcend these limits. If $n = 1$ Mr. Sosa's simple law would hold good.

(5) The influence of the diameter of the worm wheel cannot be disregarded. I have elsewhere given theoretical reasons based on the influence of curvature of the opposed surfaces upon the lubrication for supposing that the limiting thrust varies as the square root of the worm-wheel diameter or W varies as $\sqrt{D}$ where $D =$ diameter worm wheel. Mr. Sosa does not allude to this factor. As some of the statements given above are unorthodox some reasons for their acceptance must be given, but formal proof of each proposition is unnecessary.

The most important question raised refers to the influence of the tooth pitch upon the limiting thrust. All attempts to formulate rules for the safe load on worm gears have proceeded on the assumption that the magnitude of the safe load must depend upon the amount of surface contact. This method of treating the question is entirely reasonable, and if due attention is paid to the nature of the contact that actually takes place no better method can be imagined. Mathematically, however, the only possible contact that can take place is linear and though the physical properties of the opposed surfaces and the lubricant between them expand this ideal line into an actual area of very small breadth, its surface is so small as to defy measurement.

The actual area in contact at any moment will vary directly as the number of teeth in contact at that moment, the average length of the contact line across the teeth, and some function of the average curvatures. If the diameters of the worm and wheel are kept constant and the tooth pitch (and hence the number of teeth in the wheel) alone is varied, none of the variables upon which the contact area depends is appreciably affected.

It is true that undue increase in tooth pitch will lead to ultimate curtailment of the number of teeth in contact by reason of the phenomenon of interference, and consequently will actually diminish the contact area. In the other direction diminution of the pitch does to some slight extent lead to slight increase in the average number of teeth in gear at any time. These variations are, however, unimportant and it is in the main perfectly correct to state that no appreciable gain in contact surface is achieved by increase of tooth pitch.

The question of the number of teeth in contact may be made plain by means of diagrams of the central sections of a worm and worm wheel the diameters of which are kept constant while the pitch is varied. Thus Figs. 1 and 2 represent the pitch and limit lines of worms and wheels of the same diameters, the tooth pitch of Fig. 1 being double that of Fig. 2. It will be seen that the average number of teeth in contact is greater in Fig. 2 than in Fig. 1 owing to the fact that the contact path

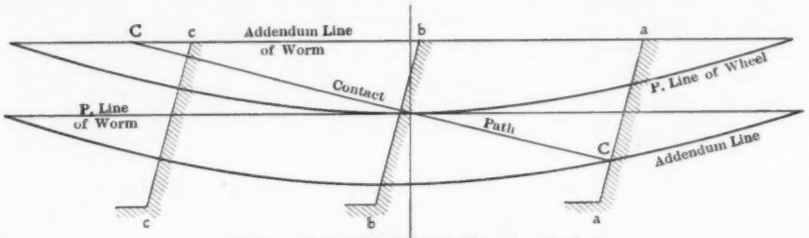


FIG. 1. Worm Wheel Double Thread 30 Teeth.

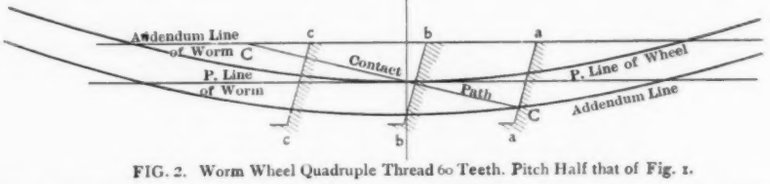


FIG. 2. Worm Wheel Quadruple Thread 60 Teeth. Pitch Half that of Fig. 1.

CC in Fig. 2 is greater than half that of CC in Fig. 1. The statement as to the curvature of the surfaces being unchanged will be plain when it is considered that when the pitch is diminished, the diameter being kept constant, the surfaces are the same but their limits are merely contracted.

Another method of arriving at the same result is to compare the actual areas of worm-wheel teeth that come into contact with the worm, when the tooth pitch is varied. It will be plain that the total surface that comes into contact in one revolution, is the product of the number of teeth multiplied by that area of each tooth which comes into contact. If the pitch is halved the area of each tooth that enters into contact is halved, but as the number of teeth that comes into contact is doubled the product of these quantities is constant.

Figs. 3 and 4 are the projections of worm-wheel teeth, the shaded areas being the projections of those portions which come into contact with the worm thread. Within approximate limits the shaded area in Fig. 4 is half that of Fig. 3 but there are twice as many teeth in the for-

mer so that the total contact surface per revolution is unaltered.

From such considerations as the above I am forced to conclude that the limiting end thrust will be independent of the tooth pitch, or W is independent of p.

The second statement, namely that W varies as d, is almost obvious and needs no justification.

With reference to the third statement as to the influence of the angle of thread, in view of the complexity of the formula involved and the slight effect on the actual results, it seems questionable whether it should be regarded in any questions relating to pressures upon the areas of contact surface.

The relationship between the end thrust W and the reaction normal to the surface may be very simply obtained by a graphical construction as follows: Lay off DB (Fig. 5) to represent W in direction and magnitude, draw AS at right angles to it and DC so that $CDB =$ the thread angle α and DA so that $ADC =$ the angle of friction (about 2½ degrees is a good average value for worm gearing). Then AD represents the total reaction and if a perpendicular AN is let fall on CD produced, DN gives the normal pressure on the thread.

The point to note is that for such large differences of thread angle as from 5 to 30 degrees the difference between CD and ND does not amount to 5 per cent. Now if a is the projected area, the actual area subject to normal pressure is $\frac{a}{cos.\ \alpha}$. If then the normal reaction be divided by $\frac{a}{cos.\ \alpha}$ we shall obtain the value of the intensity of pressure, which will be found to remain nearly constant. Increase of thread angle does indeed if anything slightly increase the intensity of pressure, but the increase is neglible in comparison with other factors.*

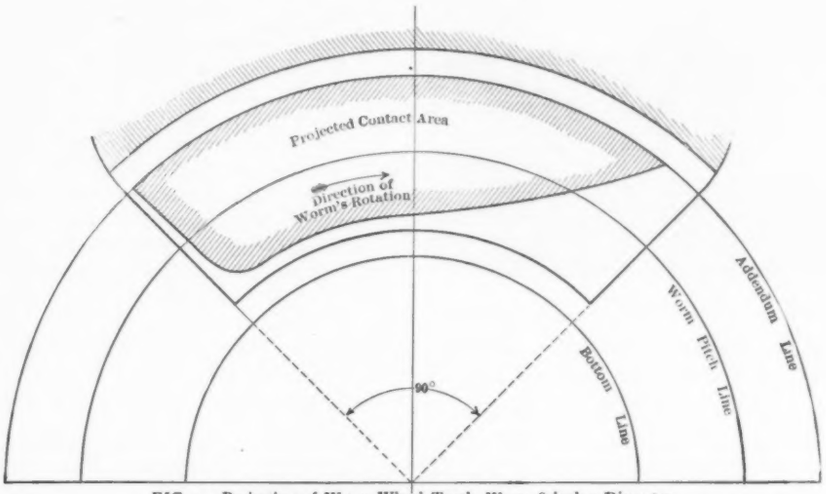


FIG. 3 Projection of Worm Wheel Tooth. Worm 8 inches Diameter. Double Thread, 8 inches Lead. Wheel 30 Teeth 4 inches Tooth Pitch. Thread Angle 16°42″

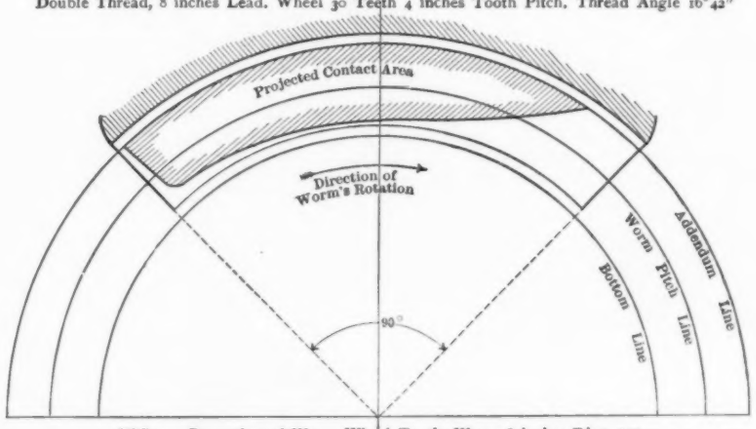


FIG. 4. Projection of Worm Wheel Tooth. Worm 8 inches Diameter. Quadruple Thread, 8 inches Lead. Wheel 60 Teeth 2 inches Tooth Pitch. Thread Angle 16°42″

It will be seen, therefore, that for equal rubbing velocities the effect of the angle of thread is negligible as regards end thrust. A worm of large thread angle will only be superior to one with a smaller thread angle in virtue of the fact that for equal values of the pitch time speed of worm, the rubbing velocity is reduced as the angle becomes larger.

* On analysis of Fig. 5 it will be seen that the normal pressure P may be written

$$P = ND = AD\ cos.\ \alpha$$
$$= \frac{DB\ cos.\ \beta}{cos.\ (\alpha + \beta)}$$
$$= \frac{W\ cos.\ \beta}{cos.\ (\alpha + \beta)}$$

which is equal to $W\ [cos.\ \alpha + tan.\ (\alpha + \beta)\ sin.\ \alpha]$.

Could the fundamental formula $\frac{P}{A} \times V = C$ be proved to hold good, as Mr. Sosa believes, his formula could be immensely simplified by writing

$$f = \frac{10{,}000}{S}\ sin.\ \alpha.$$

Thus if $S = 100$

$$f = 100\ sin.\ \alpha,$$

and for

$\alpha =$	13°	16°	19°	22°	25°	30°	35°
$f =$	22.4	27.5	32.5	37.4	42 2	48.4	57.3

whereas Mr. Sosa gives

$f =$	23	28	33	37	42	50	60

But unfortunately such experiments as Bach's give results which by no means conform to the simple hyperbolic law. In fact such a law as $\frac{P}{A} \times V^n = C$ is more in agreement with facts where n = 0.5 to 0.3.

Mr. Sosa does not introduce any factor in his formula to allow for the influence of the size of the worm wheel, yet this matter is obviously one of importance because as the size of the pitch circle increases, not only does the average radius of curvature of the teeth increase, but contact is more and more confined to such

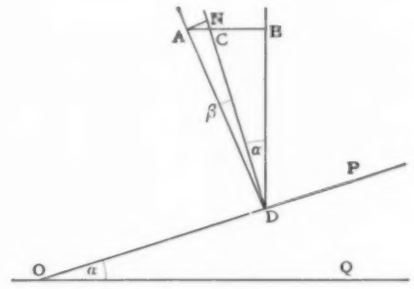


FIG. 5. RELATION BETWEEN END THRUST AND NORMAL REACTION.

portions as have the largest radii of curvature. Taking this factor into consideration it will be found that the larger the diameter of the wheel, the larger is the physical area of contact. I have from mathematical reasoning based on the curvature of the teeth come to the conclusion that the areas of contact vary as the square root of the diameter of the wheel.

The formula proposed for worm gearing is therefore of the form

$$W = d \times \sqrt{D \times f}$$

where $d =$ diameter of worm

$D =$ diameter of pitch line of wheel

$$f = C \times \left(\frac{sin.\ \alpha}{S}\right)^n$$

where $C =$ a constant to be found by experiment.

$\alpha =$ angle of thread

$S =$ circumferential speed of wheel

$n =$ an index varying with conditions but lying somewhere in the neighborhood of 0.5 to 0.3.

Leeds, England.

The Bogert Crank-Shaft Lathe.

BY HUGH DOLNAR.

This crank-shaft lathe made its first appearance early in 1906. I saw the second one that was placed in work at Blomstrom's motor-car shops, Detroit, where a drop-forged, machine-steel, 4-throw crank-shaft was finished on an ordinary lathe, ready for grinding, by a skilful lathe hand in 10 hours. With the same forging and the same workman and the Bogert lathe shown in Fig. 1, ten of these shafts were regularly turned in 10 hours, and given to the grinder in as good shape as those before requiring 10 hours of lathe work each.

This 4-throw shaft was easily made, as there was no finish except of round parts, and therefore but little straightening and re-turning were required.

The inventor of this lathe, John L. Bogert, of Flushing, N. Y., had previously produced a crank-shaft turning lathe, in which the work was placed on centers, driven from the middle, and worked with two tool posts carried on two independent saddles. This lathe was by no means ideal in action, but it contained two saddles, and carried two tools, both of which could work at the same time, and the form of the tool-post seat and support on the saddle or carriage was such as to permit holding the tool firmly in an American-style tool post, and yet was narrow enough to work in a narrow crank-throat. This narrow tool support is the peculiar and indispensable feature of the Bogert crank-lathe in which the tools must be firmly supported on the narrowest possible base. By making this tool-holder base a steel casting of unusual form, an efficient tool support, which permitted ready tool placing, was obtained.

In considering the problem of multi-throw crank-shaft finishing, Bogert saw that if the crank-shaft could be equally driven from each end much heavier cuts could be taken, because this would double the tool-cut thrust resistance, and practically make the shaft as stiff in the lathe as if it were only half its actual length. He also saw that if two tools could be placed at work on one cylindrical surface, one in front, and one, cutting on the under side, in the rear, then the cut would be in balance after the work was roughed down to round, and that this balanced cut would do away with the need for the steady rest. His first crank-lathe had used two saddles, independent, and each carrying one tool post. It was therefore an easy step for him to apply two tool posts to each saddle, making four tools in all, which could, under favorable conditions, all be at work at the same time; two on one surface, one front and one rear, both feeding one way, and the other two, also front and rear, working on another surface and feeding in the contrary direction to the first pair of tools. His first crank-lathe carried the work on centers, and used two tools at once; but in considering the work of four tools cutting at once in high-resistance steel, Bogert saw clearly the inadequate support given by the pointed center, even though both head spindle and tail spindle were driven, and conceived the idea of hinged and swinging clamp-holders for the finished crank-shaft ends, this swinging pair of clamp-holders to be finished and graduated together so as to be set to zero for the crank journals, and to throw within the capacity of the lathe, and doweled there, for the crank wrists.

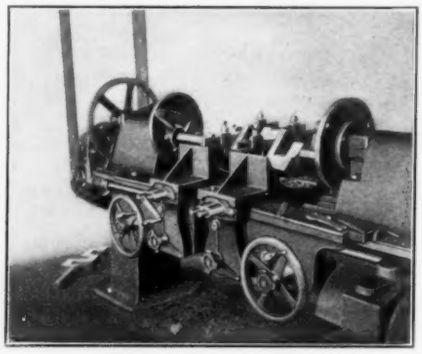


FIG. 2. THE BOGERT CRANK-SHAFT LATHE.

This made the action of the four tools ideal, placing pairs of tools on opposite sides of the work and feeding these pairs in opposite directions on different surfaces so as to oppose thrusts to each other both crosswise and lengthwise of the crank-shaft in process of finishing; while driving the crank-shaft from both ends, as shown in the general views, Figs. 1 and 2, and in the plan, Fig. 3, gave it its maximum power-transmitting capacity, with a minimum probability of distortion from cut resistance; while the carrying of the crank-shaft ends in clamps, instead of on centers, gives the crank-shaft the most efficient support possible, since it advantageously employs the full shaft-end cross-section to hold the crank-shaft in place against the tool thrusts and driving torsion.

It is true that, owing to the rough

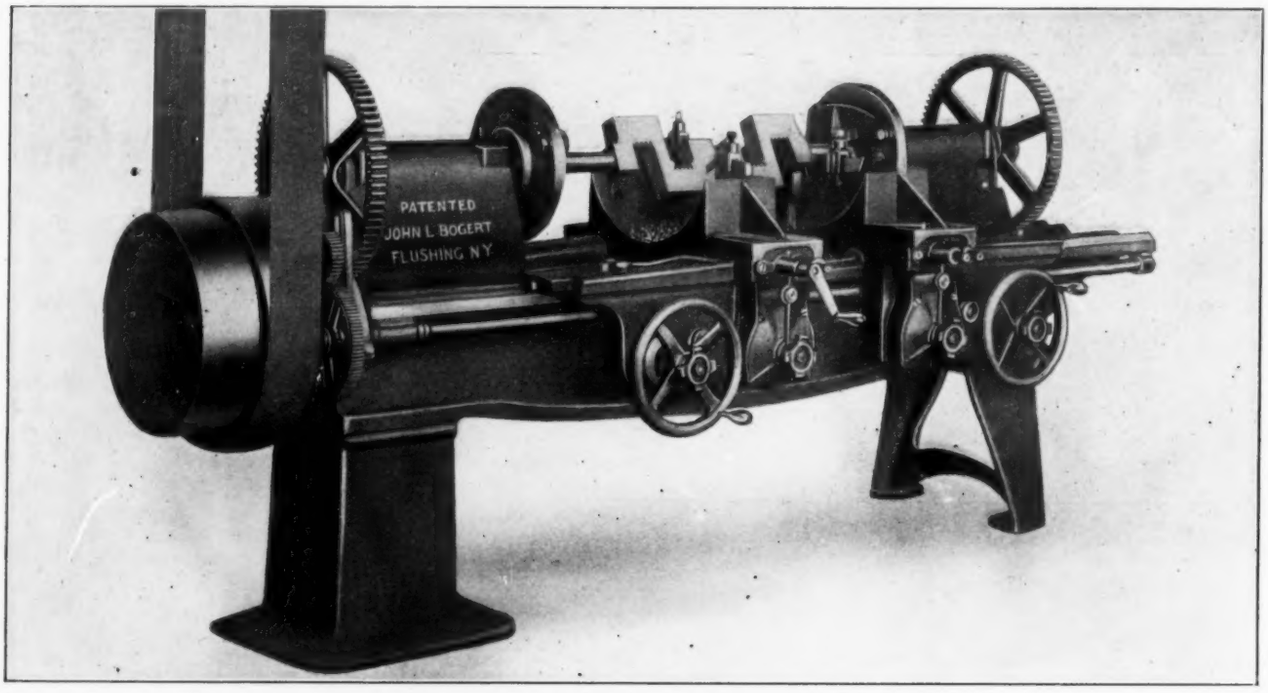


FIG. 1. THE BOGERT CRANK-SHAFT LATHE.

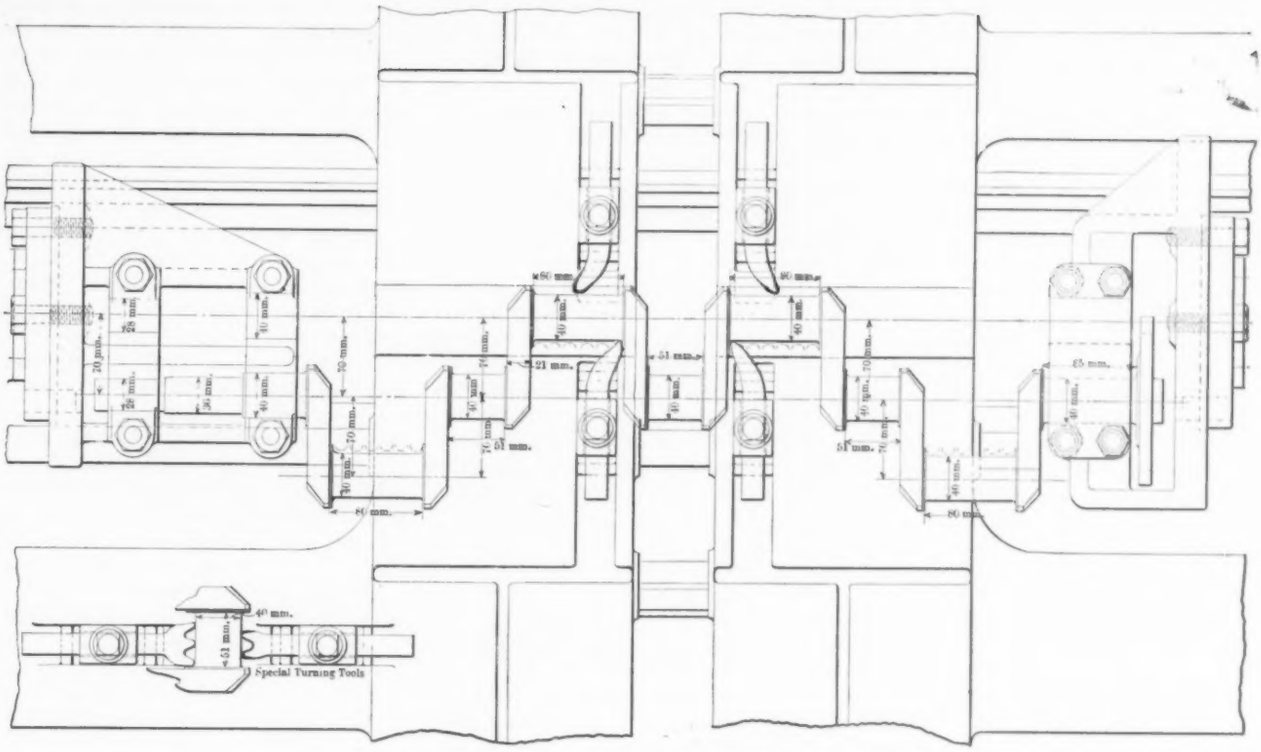


FIG. 3. PLAN SHOWING DRIVING CLAMPS AND TOOL ARRANGEMENT.

rectangular sections of the wrists and middle journal when a four-throw blank is placed in the lathe, the tool cuts cannot be always balanced against each other, and in spite of the driving from both ends the first cuts cause some lifting of the parts of the crank-shaft. But as soon as the work is nearly round, the cuts do practically balance each other, and at all times very much heavier cuts can be taken than with the single tool and the shaft on centers, driven from one end only.

Thus, in the Daimler "Mercedes" shops, a chrome-nickel steel, 45-h.p., 4-throw crank-shaft took 10 hours to true the middle bearing on an ordinary lathe, with the shaft on centers. With the Bogert lathe the middle bearing of this same crank-shaft is finished regularly in from 2 to 2½ hours, and the whole crank-shaft is finished in something less than one-fifth of the time required on the ordinary lathe. Having this general scheme clearly worked out, details were proceeded with,

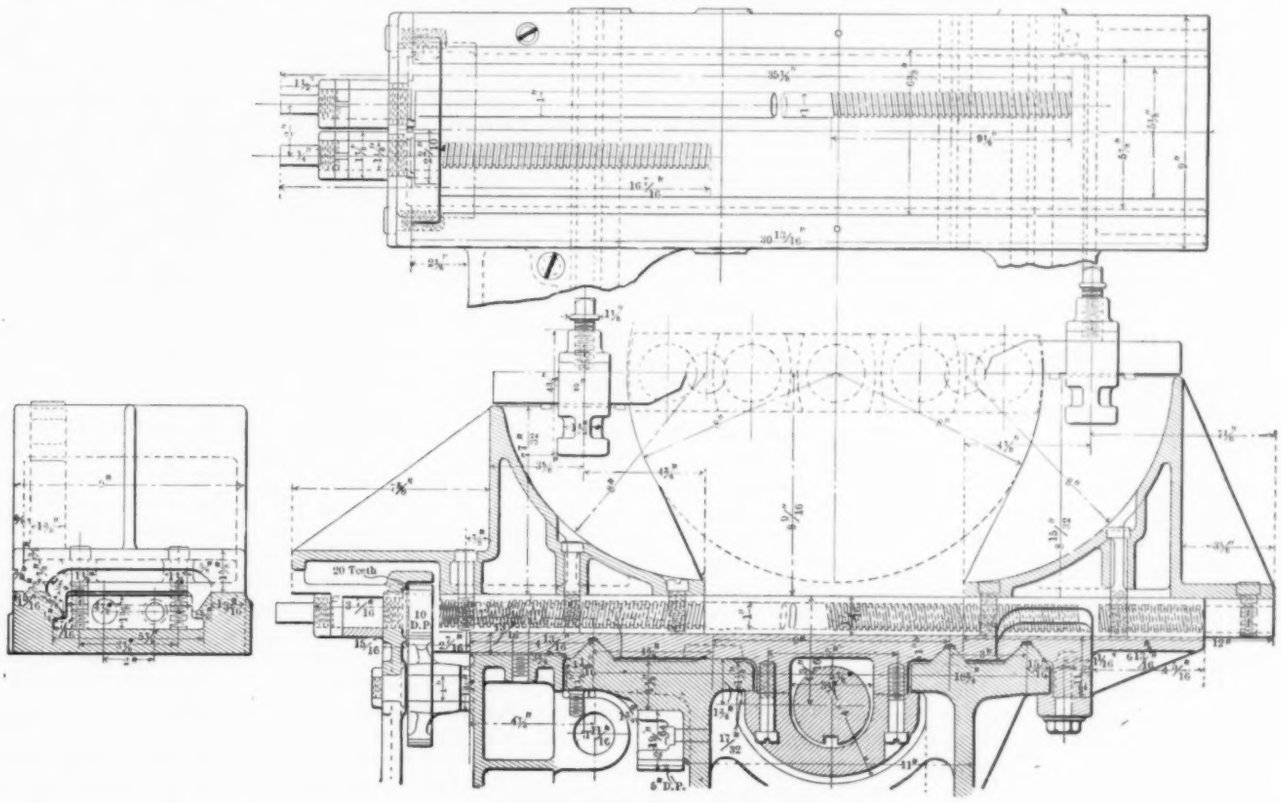


FIG. 4. SADDLE AND CROSS SLIDE CONSTRUCTION.

a driving shaft of 3 inches diameter, as large as the head and tail spindles, being provided to carry the spindle-gear driving pinions so as to insure the equal time turning of the head and tail spindles which must be maintained to gain the advantages of the system. This pinion shaft is carried as high as possible, and the saddle stiffness is maintained by a steel-casting bridge below the driving-pinion shaft, the top surfaces of this bridge being scraped to slide under the bottom of the top members of the lathe shears, as will be seen by the saddle-construction drawing, Fig. 4.

The front and rear tool posts are moved to and from the work by right and left screws, so that the removable hand crank which serves for both screws is always turned to the right to bring either the front or rear tool to the work.

All possible strength is given to the narrow tool posts, seats and slides by making them integral steel castings with ribs at 90 degrees occupying all available space. This tool-post slide is unique in form, and gives a narrower tool-post seat than seems compatible with substantial tool support, but the tool never flinches, although held in the one-screw tool post. The belt drive gives two speeds only as the tool is expected to be speeded to suit the particular shaft to be finished. A greater range of speeds can of course be had by varying the countershaft speed.

The saddle is held to the shears by 4 gibs, one under each edge of the gantry top members, all gibs, or shoes, being scraped to fit scraped under-faces. The front shoe may be packed up with liners. The other three can be adjusted only by removing metal.

The bridge carried round under the pinion shaft, maintains the saddle cross-member strength and stiffness, and prevents lift of the rear tool by flexure at the middle of the saddle cross member, and the bridge flats make the inside saddle gibs or shoes.

The work is extremely heavy on the tool-post slides, and the form of gib and dovetail and method of gib adjustment, are highly important details. In this design this snarl has been unriddled by discarding the gib wholly, and inverting the dovetail, splitting the tool slide in a horizontal plane and pinching the top and bottom parts of the slide together by vertical adjusting screfs, all as shown in the end view of the slide in Fig. 4.

The top member of the tool slide has on its under surface, first, flats on each side, then two 45-degree surfaces with vertical adjusting screws, all as shown in cal member of the adjustable shoe or gib underneath, which has eight plane surfaces all at right angles, in the section. Two of these surfaces bear on the lower hook flat surfaces of the saddle slide-way, and two are fitted to slide vertically in the wide groove in the bottom of the dovetailed slide. The bearing surfaces of the slide extending the full width of that member are in this form carried up higher than in the usual construction, and although the slack adjustment is independent, so that one part of the slide-retaining surfaces may be made tighter than another by unequal screw adjustment, a movement of the slide in the way after each screw tightening tells the workman whether the screw is too tight or too slack.

This slide and slide-way close by top pressure and are therefore right in form for tool-post carrying on the front side of the lathe, and are also adapted for resisting the upward pull of the reversed tools on the back side of the lathe, because the lift is resisted by the flat hook faces under the way dovetail faces, which are at right angles to the plane of tool lift.

This is the first instance of this inverted dovetail to come under my observation. Bogert says it is original with him, but old in his own practice. It is an extremely creditable solution of the gibbed-slide problem.

Some dimension particulars and material specifications of the crank-lathe illustrated are as follows:

The driving spindles, cylindrical in form, are 38 carbon crucible-steel forgings, 3x24 inches, with integral 7½-inch driving flanges on their inner ends to take the swinging clamp-carrying face plates doweled against turning and held up with two screws in each. Obviously it would be inconvenient, if not wholly impracticable, to screw these driving face plates on the spindles, and they are therefore seated to fit the integral spindle flanges. The spindle boxes are babbitt in the headstocks with gray-iron babbitted caps. The driving pinions are below, and wear on the spindle boxes gives downward spindle movement by box adjustment, so as to close the gears together. The spindle driving gears are gray iron, 4 diametral pitch, 83 teeth, 1¾-inch face. The driving pinions are phosphor bronze, 19 teeth, the reduction ratio being 4.8 to 1. The 2-step driving pulley is 19¼ and 21½ inches diameter for a 5-inch double leather belt. The driving pulleys are on the pinion shaft, which is machine steel, 3 inches diameter. The saddle feed rod is 1 9/16 diameter, machine steel and splined. The saddle rack, cut from the solid steel bar, is 5 diametral pitch and 1¾-inch face, and the steel-rack pinions have 15 teeth. The feed-change gears are gray iron, are 8 diametral pitch and 1¼-inch face. The apron saddle reverse is a yoke and three pinions. The drive from the feed rod to the saddles is through steel worms (3p. i.) and phosphor-bronze worm gears, the ratio being 1 to 57.

The principal dimensions are: Between spindle face plates, or longest work length, 60 inches; swing, 22 inches; length of saddles on ways, 30 inches; length of bed over all, 103 inches; total weight, about 4000 pounds; power required, 5 to 10 horse-power.

The first bearing is usually turned with the right-hand saddle, and the first cuts fed to the left. Both front and rear tools are brought into the work at as nearly the same time as may be, but until the surface is nearly round the tools work alternately.

The normal feed, both saddles at work, is to move the saddles away from each other, or both toward each other. For 6- and 8-throw crank-shafts, a middle steady rest composed of front and rear angle forks is proposed.

The tool shapes are single round points and forked tools with round or angular points, as shown in the sketch of the lower left-hand corner of Fig. 3. High-speed steels are used and machine-steel, drop-forged cranks can be turned at from 30- to 60-foot surface speed per minute. In chrome-nickel steel the cutting tools will not do well at much more than 16 feet.

Computing Wages of Government Employees.

All disbursing officers of the United States have been solemnly informed in a letter from Robert J. Tracewell, the comptroller of the Treasury, and approved by Leslie M. Shaw, of the new system of computing the wages and salaries of Uncle Sam's employees, pursuant to a section of the Sundry Civil Act just passed. Formerly the salary which any position carried was divided into four equal parts, the first of which was divided by ninety—the number of days in the first quarter—the second by ninety-one, and each of the remaining fourths by ninety-two, to get at the daily compensation. Hence, although the difference was trifling, three rates of pay, on the same salary, were operative in each year. All disbursing officers were supplied with books, looking like tables of logarithms, by which the deduction for a day in each month could be accurately made. Another computation on the same principle was made for leap-year, when an annual salary was thus cut up into 366 parts. Congress, deciding to simplify the system, has just decreed that the year's salary shall be divided into twelve equal parts, and each of these divided by thirty. A person, for example, beginning work on the 11th of February, loses only one-third of his month's salary, just the same proportion as if he had begun on the 11th of August. Irregularities at the end of the month thus do not count, although it is specified that anyone who absents himself from duty on the 31st day of the month shall lose one day's pay, or one-thirtieth of the month's pay, or one three hundred and sixtieth of the year's. Either the new plan or the old one seems unnecessarily complicated, and yet some cold, wooden, inelastic system is always a necessity in Government operation. The learned comptroller writes "where a promotion or demotion occurs," etc., thus

giving official sanction to a word in universal use in Washington, but not found in our dictionaries. "Demotion" answers such a long-felt want, the nearest substitute being two or three words, that it is unfortunately liable to find a foothold in the language, especially as everybody gets to working for the Government. "Gage promoted me and Shaw demoted him" accords with usage at the capital, even if it is not capital usage.—*Boston Evening Transcript.*

Consul H. A. Johnson, of Valencia, writes that the new Spanish tariff will check the trade in typewriting machines, most of which have been imported from the United States. The new tariff does not foster any home industry, for there is no Spanish typewriter industry or any prospects of any, and it has occasioned much dissatisfaction in commercial circles. The duty has been increased from $1.30 to aproximately $3 per kilogram (2.2 pounds) which therefore adds about $40 to the cost and freight price of American typewriters.

The report of the Bureau of Manufactures states that during 1904 machinery to the value of $82,028,000 was exported.

An English Lathe-Feed Mechanism.

BY I. W. CHUBB.

Among British toolmakers, the Yorkshire Machine Tool Company, Liversedge, near Leeds, has lately made some of the greatest relative advances. The machinery has in all cases been re-designed, and the firm is now taking its place in the front ranks. The company has recently patented an improved lathe carriage longitudinal and cross-feed mechanism, which is shown in the illustrations as applied to a 17-inch (8½-inch center) lathe. The bed is of the usual English form, and in many respects the carriage does not call for special comment. The new device consists of a quadrant plate *A* carrying gears which are used for communicating either a forward or backward motion to the trains of gear wheels provided on the carriage for the feeds, so that there are no bevel wheels, clutches, sliding pinions, or friction gears. Furthermore, of the turning, facing and screw-cutting motions, any two can be locked out of gear while the other is in action, this applying both to forward and backward movements. The quadrant plate *A* swivels on a pin fixed to a gear box behind an apron plate *B* which forms part of the carriage. The quadrant bears a gear wheel *C* which rotates on a bearing carried by the fulcrum pin. This pin is placed over the feed-shaft so that the gear may be driven from a sliding worm *D* splined to the shaft. The plate *A* also carries a second pinion *E*, Fig. 5, which gears both with the driven gear *F* and also with a third gear *G*, from which is obtained the reverse motion. Thus the positions of the second and third gears can be changed by one controlling lever simply by swiveling the quadrant about its center, a suitable stop pin *H* on the lever holding it in position. Then forward or backward motion is given to a train of wheels which impart motion for facing, or the pair of gears on the quadrant plate can be moved out of mesh with the cross-feed train, and into gear with a train of wheels provided for sliding the carriage. In either case the forward motion is obtained from the wheel *E* on the quadrant plate, and backward motion from the wheel *G*. Thus in turn one or other wheel may gear with one or other of the two trains of feed gears, both trains being supported by the gear box or apron, the longitudinal motion being obtained by the use of a fixed rack. This is shown in Fig. 4, which gives a section through the rack pinion

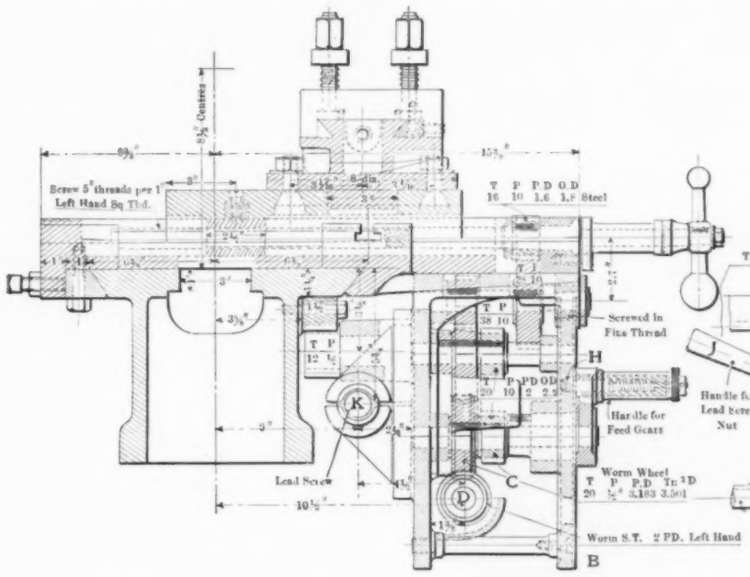


FIG. 1 Tranverse Section

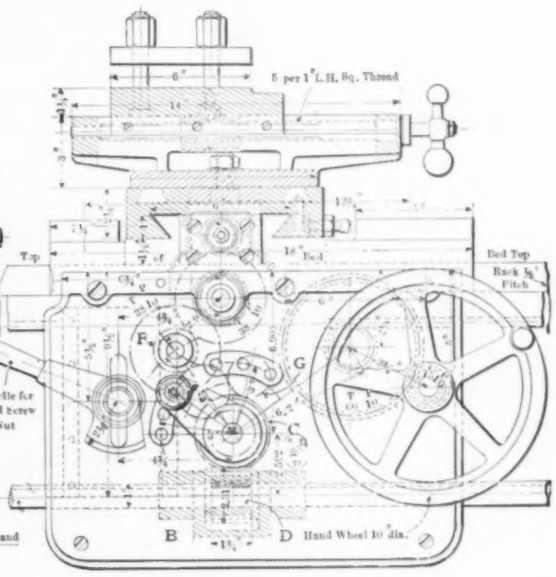


FIG. 2 Front Elevation of Carriage

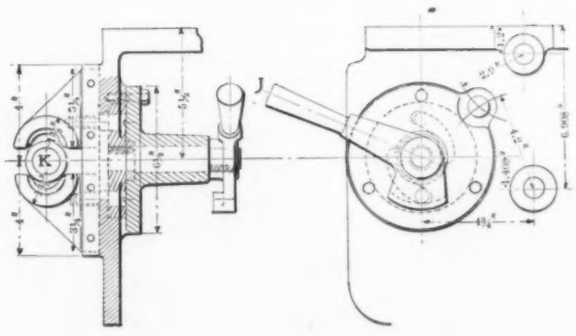


FIG. 3 Detail of Nut Box

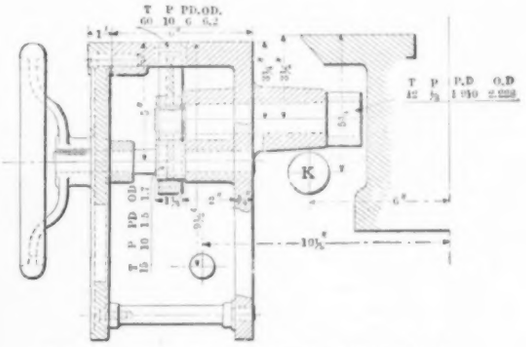


FIG. 4 Transverse Section of Carriage showing Rack Pinion and Hand Motion

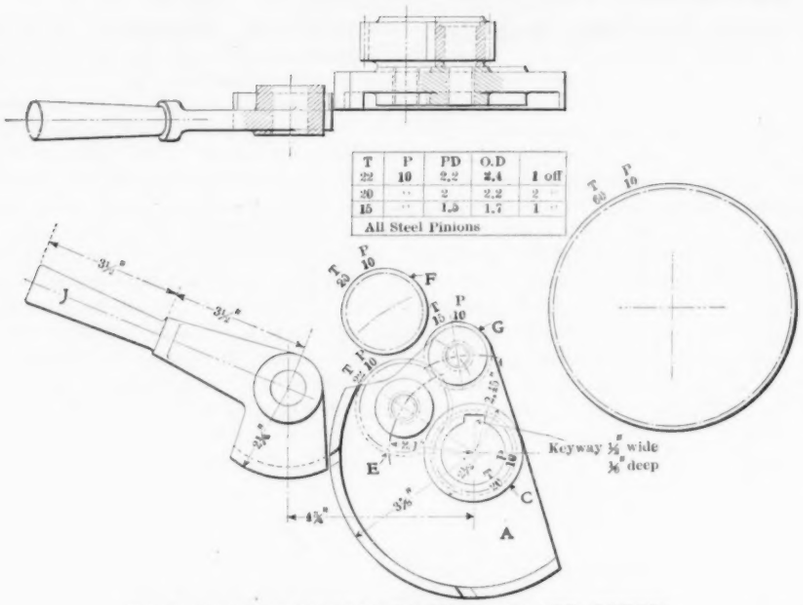


FIG. 5. DETAIL OF INTERLOCKING DEVICE AND FEED PINIONS.

and hand motion. In the lathe illustrated the cuts per inch are: turning, 12, 16, 22 and 30, and facing, 28, 38, 50 and 66.

A feature is the use of one controlling lever only both for forward and backward motions. The stop pin *H* enters one of six recesses in a plate attached to the face of the apron, for determining the position and for holding the quadrant plate *A* there. Four positions are working positions, turning and facing, backward or forward. The others are out-of-gear positions, and it is only when the lever is placed into either of these that a second lever *J*, used for engaging a split nut box on the lead screw *K* (see Fig. 3), can be moved so as to give the ordinary screw-cutting motion to the carriage. For the locking device the quadrant plate is provided with a flanged segment (see Fig. 5), which prevents movement of the nut-operating lever except at the two positions mentioned. Openings in the quadrant segment flange then allow a sector on the screw-cutting lever to enter. At the same time this locks the turning- and facing-feed trains out of gear. Thus is prevented accidental engagement of the screw-cutting motion while the cross- or longitudinal-feed motion is in gear; also the simultaneous engagement of any two feeds in either a forward or backward direction. Fig. 6 shows the complete lathe with the improved saddle, but with the top slide, etc., close to the fixed steady. A better view of the mechanism can be obtained from Fig. 7, which shows the front apron plate removed. The sector on the nut-box handle has a return flange piece which, as explained, to put the nut in gear must go through one of the notches shown on the surfacing-handle quadrant.

A machine shop 160x102 feet recently built of reinforced concrete at McKees Rocks, Penn., cost approximately 3¼c. per cubic foot.

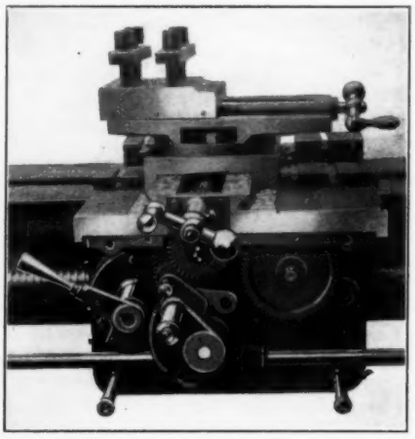


FIG. 7. VIEW OF CARRIAGE WITH FRONT APRON PLATE REMOVED.

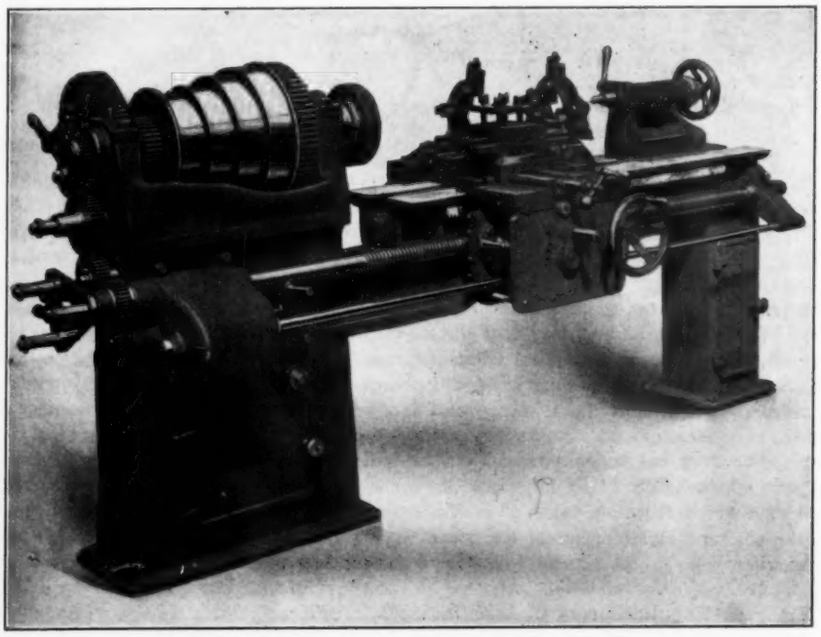


FIG. 6. ENGLISH LATHE WITH NEW FEED MECHANISM.

A Design for a Headstock for a Grinding Machine.

BY H. F. NOYES.

This headstock was designed to meet the following conditions: The dimensions and proportions of the base were fixed by the general design of the machine for which it was to be built, as was the location of the headstock spindle with reference to the base, and the total length. It was desired to provide an all-gear drive of 12 speeds, instantly obtainable, ranging from about 6 to 150 revolutions of the spindle per minute in approximately geometrical progression. At the start it was recognized that the design was likely to have a top-heavy appearance, but the idea was to do the best we could with the given conditions.

Owing to the confined length of the headstock, the only practical way to work in the 12 speeds seemed to be by using three shafts and two sets of gears, one of four speeds and one of three speeds, and using some form of internal clutch or key. A pitch of 10 and width of face of 1 inch were decided on as most suitable to the conditions, in which decision actual theory did not have much influence.

Starting with 6 revolutions an approximately geometrical series would be 6, 8, 11, 15, 20, 27, 36, 48, 64, 85, 113, 151.

The next step to be determined was the form of clutch and diameter of the shafts. There is a multitude of these internal clutch or key designs, most of them, however, of the form of a sliding key. There is also one other form at least in which plungers are used, but it is quite complicated and difficult to make. The chief difficulty with all of these devices

is that they are too small for the shocks which they must withstand. In most cases the designer seems to have assumed that because certain proportions have been found suitable for keys under ordinary conditions, the same proportions would be suitable for a sliding key or clutch which has to withstand shock, when the duty is much more severe.

In this case a plunger type of key was determined on, of a diameter sufficient to give a width of clutch surface equal to the length of the hub, and a diameter of shaft sufficient to give the plunger a good length of bearing; the shaft being finally made 2 inches in diameter and the plunger 1 inch. While this shaft might have been lightened by boring out, the additional weight was not considered of sufficient disadvantage to justify this extra expense.

In order to keep down the length of shaft necessary to obtain the required number of changes, each shaft was provided with a number of plungers equal to the number of change gears on that shaft, the plungers being located such a distance apart that by moving the shaft one plunger would be disengaged before the next was ready to engage the next gear. To draw these plungers out of engagement bronze rings were interposed between each gear, and the edges of each plunger, where it would engage the ring, were bevelled to an angle of 45 degrees. The top of the plunger which engaged the gear was shaped into a shallow key, of ½ inch width and about ⅛ inch depth, the depth being shallow on account of the fact that any increase in depth resulted in a decrease of the width of face, which is far more important than the depth.

The gears which these plungers were to engage were made of steel, case hardened, and each provided with four slots, so that only one-fourth of a turn was necessary before the plunger would find a slot to engage, an arrangement which also reduced the wear on each slot.

This arrangement of plungers and moving shaft enabled us to obtain the four changes on the upper shaft with a total shaft movement of less than 1½ inches, and the three speeds on the intermediate shaft with a movement of about 1 inch.

Having decided on the form and design of clutch the next step was the size of the gears, the smallest being determined by the smallest amount of stock allowable around the shaft. In figuring the gears in this case I do not know that there is any other method than that of cut and try, starting with the smallest allowable diameters of gears and figuring in the others to get the desired speeds, and then trying various other combinations to keep the whole within the smallest possible limits.

A constant speed of 100 revolutions for the first shaft was finally chosen as giving the best general arrangement, and the driving pulley was made with a long hub, or sleeve, within which the plunger shaft slides, driving the latter by a feather, and the end of the pulley hub was provided with a cap to keep out dust. At the other end of this shaft a bushing was made of a length greater than necessary for wearing qualities in order to provide end thrust for the gears, and maintain an outward symmetry of hubs on the casing. The arrangement for oiling the gears consisted of a spiral oil slot connecting with the oil groove in the long bushing, and passing between the plunger holes in the shaft.

The first intermediate shaft contains seven gears giving, evidently, four speeds varying with the clutch gear which is in engagement on the upper shaft. The second intermediate contains three gears so proportioned as to continue the regular steps of the first four. For instance,

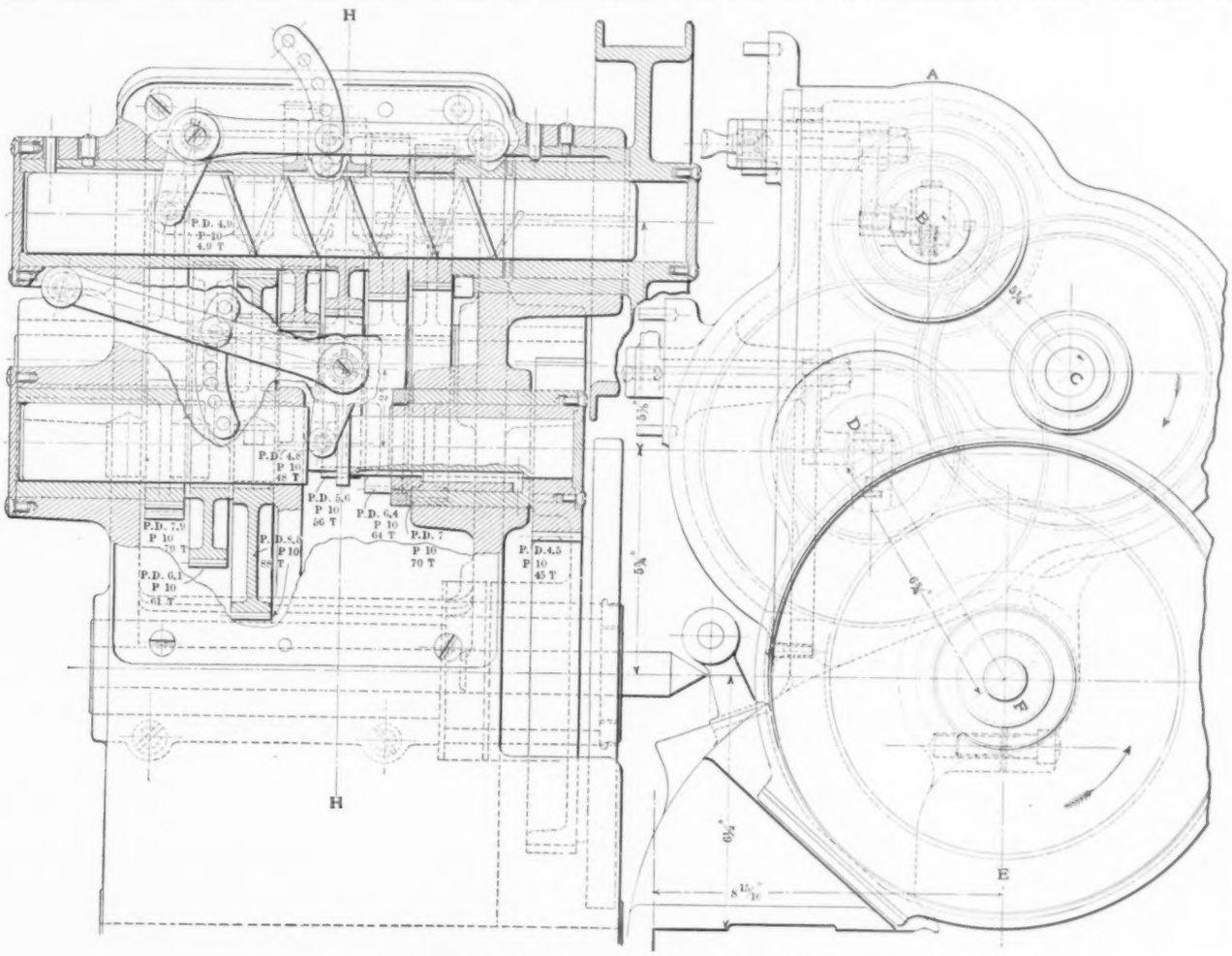


FIG. I. LONGITUDINAL SECTION AND END ELEVATION OF HEADSTOCK.

the four steps of the first shaft with intermediates of 22 to 88 teeth will give approximately the first series of 6, 8, 11 and 15 revolutions; with the intermediates of 49 to 61 it will give 20, 27, 36 and 48, and with the intermediates of 79 to 31 it will give 64, 85, 113 and 151.

The end of the second intermediate shaft is provided with a feather and slides in a sleeved pinion which drives the face-plate gear directly. These latter gears are made with a slightly spiral tooth, of about 15 degrees angle. The reason for this is that there seems to be some objection to the use of straight-toothed gears on the face plates of grinding machines, in that there is a claim that they will produce chatter marks. This is not usually so, but while I have not absolute proof of it I have seen some pretty good demonstrations made which seemed almost conclusive proof that straight-toothed gearing will have this effect under certain conditions. I am aware that I am going contrary to Mr. Norton's belief in this statement, as he distinctly states in his little book on grinding that gearing does not have this effect, and gives some pretty conclusive arguments to substantiate it; nevertheless, I am still open to conviction, and believe no one will deny that spiral gears will run more smoothly.

Letters to the Editor.

Doing Worthless Work.

With all that has been said, there is one phase of the worthless work question that I don't remember to have seen discussed. It relates to the numerous jobs, big and little, which a shop does for itself. Only rarely do they receive enough consideration to give the best return for the money.

To be convinced, go out and look under the benches and in the out-of-sight corners. Ten to one you will unearth a collection of traps of all sorts, some never completed, others that served some temporary purpose and were long ago forgotten. You paid good money for all of them. Oh! of course, they "were made in odd times and didn't cost anything," except that work of that sort costs more than any other.

Then too, what about all the little and big "improvements" that are made around the works? Do they all really improve? To be sure, "all the carpenter had to do was to put up a couple of posts and a brace across," or may be it was "just some stringers out in the yard with a few planks on them;" but by and by it was found to be in the way, and nobody used it anyhow; so down it came again.

It doesn't take much of this sort of thing to eat up a good deal of money.

Now what are you going to do? Keep on letting anybody and everybody have any and every sort of job done that he thinks he wants? Or will you issue an edict that no work shall be done without your written order? Probably the latter, and then turn down, on general principles, all suggestions but your own. Honestly, that won't make much improvement.

How, then, shall we so manage things that the foolish and unnecessary shall be avoided and the needful be done in the best and cheapest way? The problem is stated no differently from that of good management along any other line.

Order and discipline require that every job in the shop should be handled in the same systematic manner. If it pays on your customer's orders it pays on your own. If order and discipline be not maintained in this class of work just as in any other, you are keeping a school for loafing, soldiering, and unlimited "government jobs."

It is found that profitable manufacture requires careful scrutiny of the customer's order or the trade's demands, decisions as to the best methods of meeting these requirements, preparation of proper and

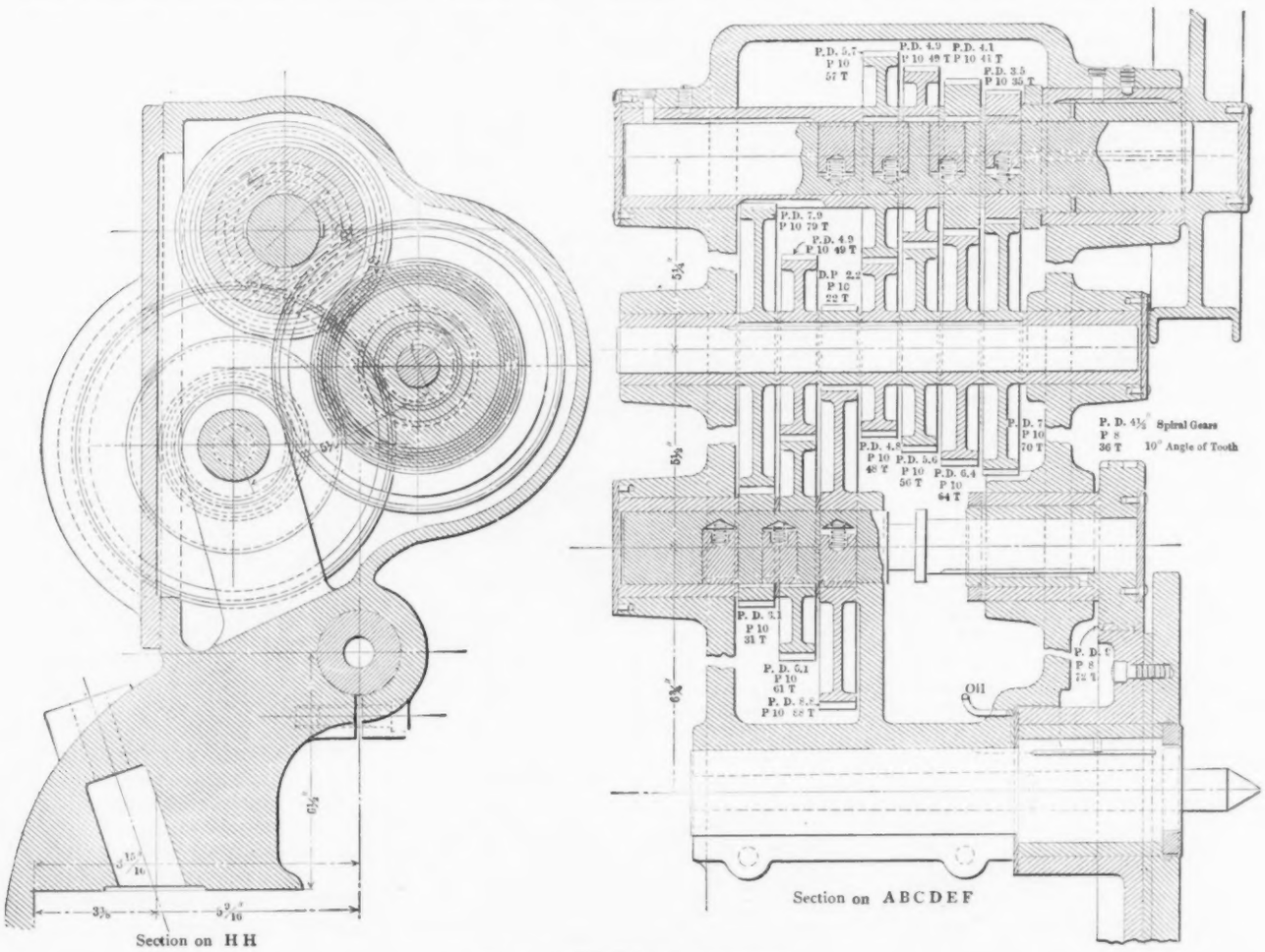

P.D. 5.7 P 10 57 T
P.D. 4.9 P 10 49 T
P.D. 4.1 P 10 41 T
P.D. 3.5 P 10 35 T
P.D. 7.9 P 10 79 T
P.D. 4.9 P 10 49 T
D.P. 2.2 P 10 22 T
P.D. 4.8 P 10 48 T
P.D. 5.6 P 10 56 T
P.D. 6.4 P 10 64 T
P.D. 7 P 10 70 T
P.D. 4½ Spiral Gears P 8 36 T 10° Angle of Tooth
P.D. 3.1 P 10 31 T
P.D. 5.1 P 10 61 T
Oil
5¼
6⅝
6¾
3⅜
Section on H H
Section on A B C D E F

FIG. 2. SECTIONS OF HEADSTOCK.

accurate instructions to the shop, obedience to these instructions, application of the best and quickest methods, complete reports of all material and labor, and for the future, analysis and discussion of costs.

The same attention should be given to propositions involving work by the shop for its own accommodation.

It is important that these propositions, requiring the expenditure of money, should be passed on by someone competent to judge both of their desirability for the purpose and of the probability of getting an adequate return for the money. He must know the details of the work and of the plant, and the financial position and policy of the company. This points to a pretty responsible man.

Can't he do it? Too busy? Well, it doesn't pay to be too busy to look after your own business. Turn some of the present work over to your able assistants and look into this yourself for a while, if you never have done so. You'll be surprised. First give that order that absolutely no work is to be done out of the regular course of manufacture except with your written permission.

The first question you will ask about the first thing that come up is "what is it going to cost?" *Ergo!* A request for work to be done must be accompanied by an estimate. This is valuable in two ways. It saves your time, and it educates the party making it. For the latter reason you better have him include in it not only the labor and material, but the percentage of burden the job ought to bear to pay its proper share of plant expense. *Don't forget that burden.* It is the hardest thing to get the shop man straight on. Don't let him confuse it with *profit.* It is *dead loss* if you don't get it.

It will cost so much. Now, what will it pay? Oh, yes, doubtltss it will be convenient, but *what* will it pay? Dollars and cents! Now be as pessimistic as you know how, but reasonable withal. The other fellow will try to "make good" and defend himself. You need to be convinced. This isn't an emergency job. Send him back to look it over once more. Ten to one he'll think of a better way, for very likely it was his first idea and not carefully considered. He hasn't learned that yet.

Perhaps you'll find that it won't pay at all; or that although a good thing in itself there is not likelihood of sufficient use to bring full return; or you will have knowledge of some impending change that would soon render it obsolete. Perhaps the request will bring to light some faulty design or process which can easily be corrected. All in all, you will find occasion to "turn down" a large proportion of these requests; *at the start,* a very *large* portion.

One of the first distinctions you will need to make is as to the class of the expenditure. Is it a betterment, like a drawing, pattern, or tool that can be used again and again till worn out, or like an addition to your buildings or machinery? Or is it shop expense, which you must bear, such as repairs, general supplies, temporary changes and additions? Or is it an expense for some customer's order and so chargeable to it? Perhaps you will have to divide it between these classes.

If a betterment, the inventory value of your plant is increased, and you have the opportunity of taking note of it right now. If a shop expense, can you afford it, or can you afford to neglect it? If expense for a customer, will you get paid?

Well, most of these requests have been denied, and the rest have been so modified as to be satisfactory. Doubtless you consulted foremen, draftsmen, cost clerks, and sales manager before you could decide on some.

The order for the job has gone to the toolmaker or blacksmith or carpenter. Will they do just what you discussed with the foreman and others and what the estimate covered? they certainly won't unless they are told; and so you see an exact specification should accompany the estimate to your pigeon hole, and a copy of it go out with the order. It ought to be explicit too, "as per sketch herewith" or the equivalent so that six weeks later you will have no haggling about it.

You may lie back and smoke if you want to, and can afford it.

Of course you have a cost system of some sort and the time and material tickets for the things you approve will ultimately all come in and be debited and credited and you will get a report. Where's that estimate? Jumping Jemima! What's the matter here? This was to have cost only $9.40 and here are tickets to show that it ran up to more than forty dollars. What in thunder! Here's the sketch too, and its only a little simple bracket affair with a cam to tighten and some hardened bushings. Why, you could have made it yourself in less than a day. Of course "the trouble is that the blacksmith made a little mistake in forging it up which wasn't discovered until the bushings had been put in and so it had to be made all over. And it took quite a lot of fitting, more'n we expected, getting it to hold just right, 'n that run it up some."

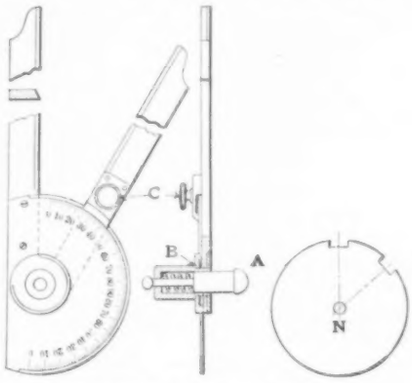
This is no fanciful experience. It takes a lot of pounding and a lot of patience and of persistence to convince everyone that all work costs money, that the dollars you pay for gimcracks are quite as big as the ones you take in trade, that your own work deserves as much attention as any other.

No two shops need exactly the same details of management. There is no "best system," and your own conditions must determine to what extent you will systemize your betterment and expense work. If your office is all under your hat your best system is just plain common sense. From there it runs up to the most modern methods with card-ledgers and tabulating machines and all the fixings. Give it as much as you like and your business will stand, without losing sight of the basic common sense, and you will add a welcome per cent. to profits. Watch out sharp for worthless work!

E. R. DOUGLASS.

A Protractor.

Here is a sketch of a tool I designed recently for laying out engine shafts where two keyways are required as at *N*. Referring to the section it will be seen that



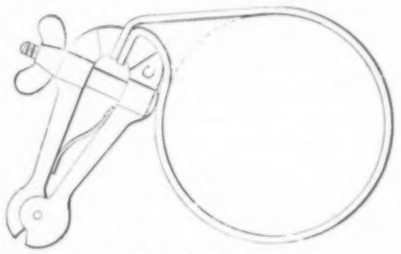
THE TOOL AND THE WORK.

A, having a spring behind it, will adapt itself to deep or shallow centers. *B* is a washer with its face hollowed a little to give it spring. To use this tool set the blade to the required angle, then insert *A* in the center at the end of the shaft, then press the tool tight against the end of the shaft and scribe the lines.

Iowa. H. J. CHINNECK.

Removing Delicate Work From Threaded Mandrels.

When one has a lathe job on a threaded mandrel it is often quite a difficult thing to unscrew it when finished without spoiling its appearance. A carpenter's wood clamp answers very nicely, but would not



REMOVING DELICATE WORK.

do when the job is a delicate one, as it would twist it out of shape.

A piece of leather belting held in a hand vise as shown in the illustration, will do the trick. The belting must be left long enough to allow the jaw of the hand vise to kink it in at *C*. This will be found very effective without injuring the work.

ARTHUR F. MILLER.

Arbor for Making Gear-Cutter Forming Tool.

The arbor shown in Fig. 2 was designed for making forming tools for cutters for gears of small diameter. The cutter, a double one, as shown in Fig. 1, is used for cutting the outside diameter and the teeth, two at a time, in cast-brass gears for the intermediate train in water meters. The gears have 40 teeth of 26 pitch, and are cut in strings, a number of them being forced onto a parallel arbor. The forming tool is clamped into the arbor, and the cutting edge turned and then formed with a commercial gear cutter as though it would be a section of one of the gears that are to be cut. When forming the teeth on the forming tool with a commercial gear cutter it is well to cut to within 0.01 inch of the required depth, then stone one of the teeth on the cutter to a smooth edge, lock the spindles of the milling machine, and finish the depth by shaving.

H. E. R. MANBRAND.

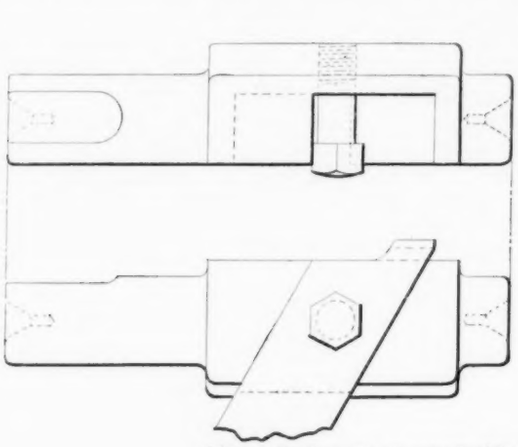


FIG. 2 Arbor for making Forming Tool for Cutter

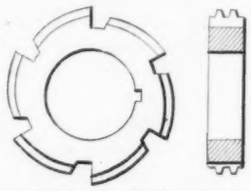


FIG. 1 Double Gear-Cutter

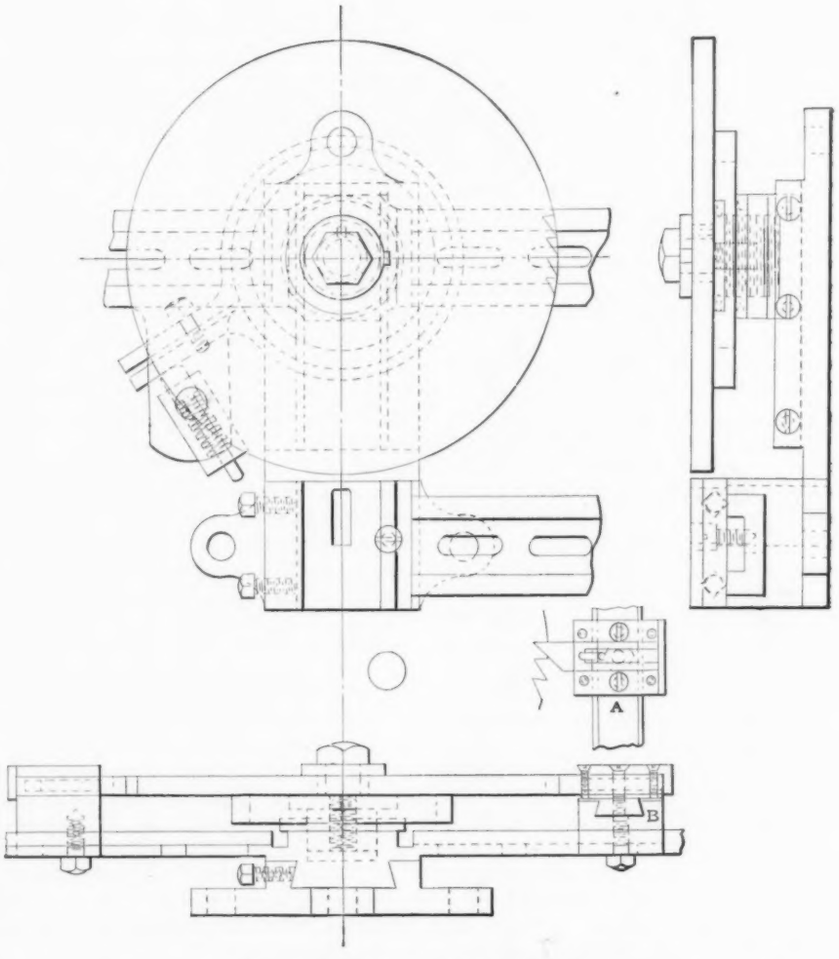
A Notching Fixture for the Punch Press.

One thing that causes a great deal of trouble in a press shop is that in a great many cases the index fixtures are so constructed that when a lot of plates have been notched and the press is changed over onto another type of plate and then there is another order for the type of plates that were cut first, considerable adjusting of the die and the indexing arrangement is necessary to get the notches just the same as they were in the original plates so that the two lots can interchange one with the other. The drawing shows an attachment that overcomes this difficulty, the index finger being fixed always in the same relation with the center and the die.

In the first place the dies are made with one side straight and held down by a fillister-head screw while the other side is planed at an angle where the clamping screws are set up to tighten it against the square side of the bolster; the reason for this method being adopted is that all the dies can be easily ground to gage to as fine a limit as is practicable for the work required.

As shown in the plan, the main part of the fixture is a casting carrying a central post or stud for the plates to revolve on and having a bolster or die holder which is machined central with the stud. There are also three projecting arms that are slotted out and provided with elongated holes at suitable distances for fixing the index finger and pawl to suit the different diameters of plates. The plan shows also the brake and the spring stop that take up any irregularity in the throw of the pawl and always bring the plate against the index finger. The plates are cast with a ring on the under side that is turned to fit the band brake, which is shod with leather and adjusted with a screw to the required tension. The vertical stud in the fixture is carried by a slide which can be adjusted along a dovetailed slot in the base to accommodate the various sizes of plates, and the lock nuts on the threaded post shown in the side view form means of adjusting the plate vertically to bring it level with the die when the latter is ground. I may mention here that steel-faced iron is the right material for notching dies. After a die is ground down 1/8 of an inch it has lost its size due to the slight amount of clearance which is necessary. When steel-faced iron is used the thickness of the steel is slightly tapered, and the iron can be backed off so as to give plenty of clearance, leaving enough metal to strengthen the die when it is ground thin.

Of the three cross arms on the fixture, one is to carry the index finger and the other two to carry the pawl slide *A* which



A NOTCHING FIXTURE FOR THE PUNCH PRESS.

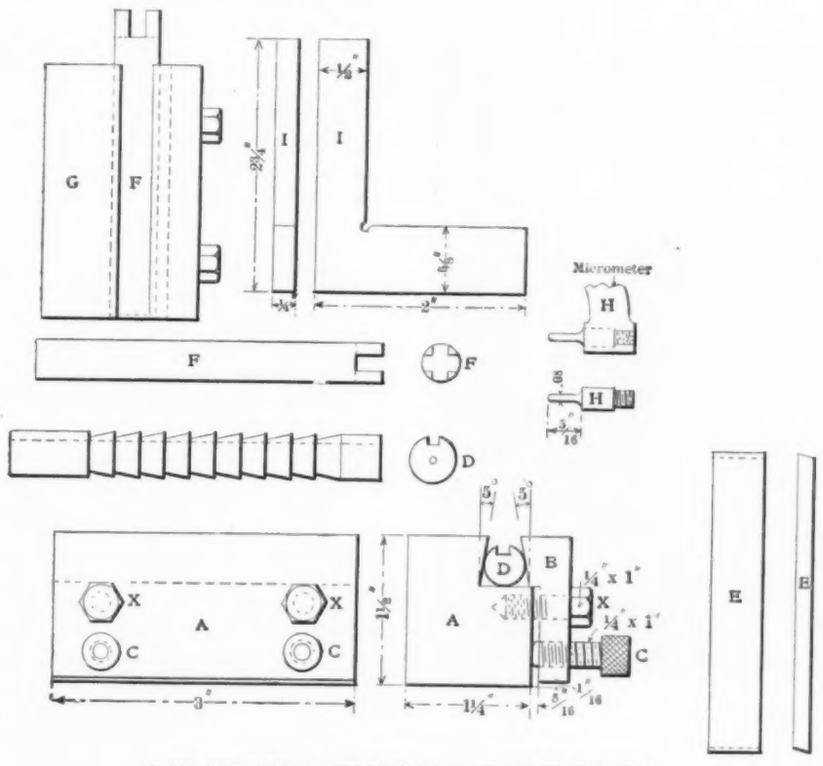
is fitted in guide blocks (one of which is shown at *B*) so as to slide freely. Both guides are made so as to be adjusted to suit the different sizes of plates. The amount of throw required is given by the usual adjustable eccentric on the end of the shaft. The indexing pawl is fixed on the sliding bar *A*, as shown, by two screws, and is fitted with a spiral spring (not shown) and also with a stop pin to keep it from shooting too far out. It is held down by a plate secured by four small screws. The arrangement of the index finger is the same as the pawl except that it is fastened directly on the slotted arm. Two tapped holes are provided in the underside of the adjustable block, so if one hole comes over the space between the slots the holding-down screw can be put in the other.

C. PETITJEAN.

London, Eng.

A Jig for Holding Broaches While Being Ground.

This jig is used in connection with a magnetic chuck. It is shown at *A*. *B* is the clamp, *C* is a set-screw for adjusting the clamp and *X* is the cap screw for tightening it. The broach is shown at *D*. It is held so that the keyway may be ground to size. For small work say ¼ inch diameter the liner *E* is used. This jig will handle work from ¼ to ⅞ inch diameter. It is handy for holding any round



A JIG FOR HOLDING BROACHES WHILE GRINDING THEM.

work such as, for instance, the piece *F*, which has two slots in one end of it, about ¼ inch deep, at right angles to each other. The jig is shown at *G* standing on end to grind these slots. After the piece is put in the jig it does not require resetting; when one slot is finished the jig is turned quarter way round and the other slot is operated on, the jig being placed against the back strip of the chuck. In making this jig it must be ground square on all sides and ends so that the work will come the same.

I have made some spare points for my B. & S. micrometer like *H*. They are for measuring the depth of keyways and I find them very handy. The square *I*, made of ¼-inch sheet steel hardened and ground all over, is very handy in connection with the grinder for setting work.

CHAS. W. TUCKER.

Adjustable Drill Jig.

Fig. 1 shows a simple, adjustable jig designed for the purpose of drilling the

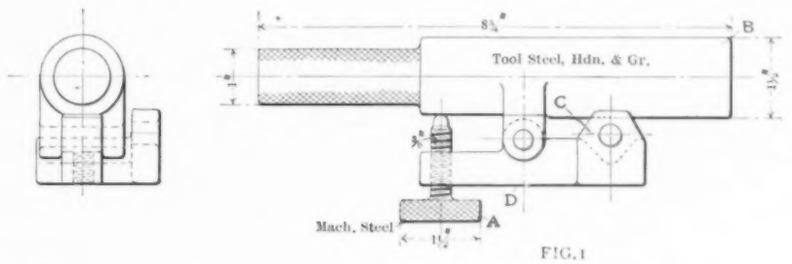


FIG. 1

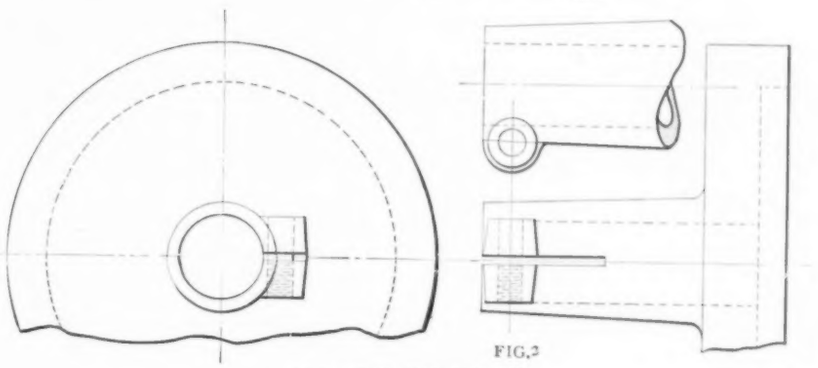


FIG. 2

THE WORK AND THE JIG.

hole in the clamping-screw lug of the piece Fig. 2, true with the circumference of the lug, irrespective of any variation in the distance between the center of the lug and the center of the bore of the hub.

The nurled screw *A* of the jig is first loosened and the plug *B* inserted in the bore of the hub, until the drill guide *C* is over the lug, then by means of the screw the end of the rocker *D* containing the 90-degree *V* is forced against the lug, thus centering the hole for the drill true with the lug.

S. B.

Casting Oil Grooves in Babbitt Boxes.

In looking over some back numbers of the AMERICAN MACHINIST I saw an article in Vol. 27 at page 1177, entitled "How a Spiral Oil Groove was Formed When Pouring a Babbitt Bearing."

The plan seems to be a very good one when you have the half-round wire, mandrels and reamers at hand, but it is so often the case you do not, particularly if you are away from the shop on a repair job.

Some years ago I had a job repairing some wood-working machinery that had been through a fire and had occasion to pour some solid boxes for a high-speed shaft that was difficult to keep well oiled, so I decided to put a spiral in them. I was 25 miles from a shop and its facilities, so I hit upon this plan: I oiled the journal fits on the shaft and then took a

piece of paper that would reach once around the journal and secured it with a piece of string about 3/16 inch diameter wound in a spiral of about ⅜-inch pitch. I wound it tight so as to make it as near half round as possible to aid in removing after the box was poured. When the shaft is thus prepared, level it in position in the boxes and pour as usual, after securing the ends of the boxes. When sufficiently cooled remove the boxes and take hold of the string and pull it and your paper out and you have your spiral.

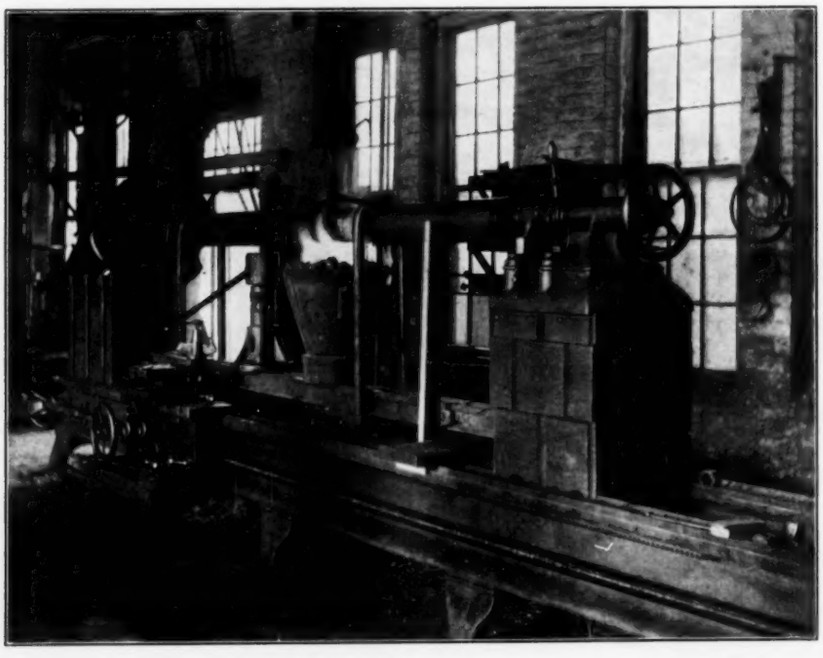
If the babbitt is very hot it will burn the string, but the char is easily removed with a piece of wire.

The size of the groove and spiral depend on the job in hand. If you haven't any drill to drill the oil holes from the outside to the spiral, put a stick in the hole drilled in the box and remove it after the box is poured.

This may be old but it was new to me and doubtless will be to many of your young readers, and it insures a good oil passage. E. T. Strang.

Straightening a Large Shaft.

In the accompanying illustration I show a rig I made for straightening shafts. The shaft, in this instance, was 8 inches in diameter by 11 feet and 6 inches long, and was 9/16 of an inch out of true at the part over the forge. I first raised the lathe up, as shown, then made two U-bolts



STRAIGHTENING A LARGE SHAFT.

2 inches in diameter; with cross-pieces and nuts. Then I cut two 90-lb. steel rails and placed them side by side in the U-bolts as illustrated, then made the portable forge and rigged up an air supply for it.

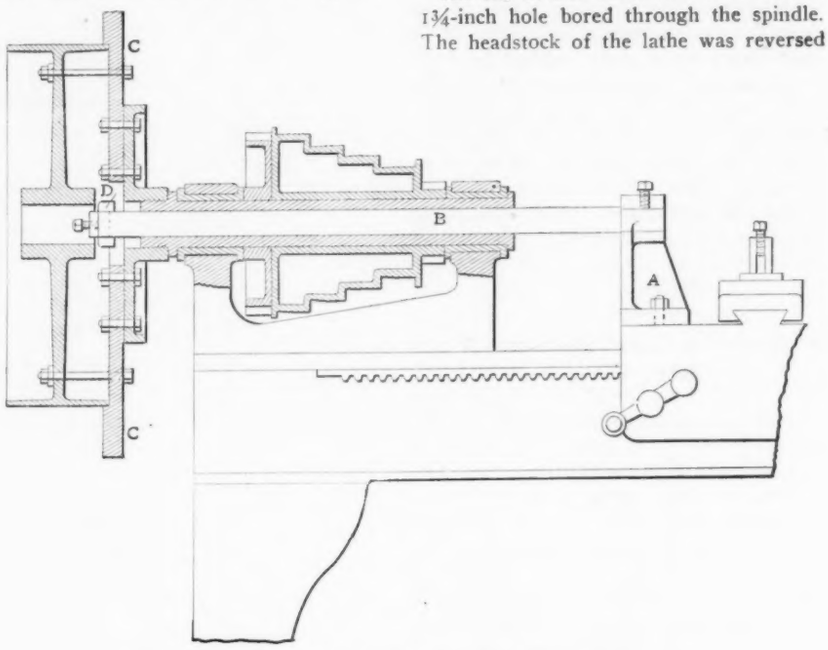
I started a fire in the forge, at the same time revolving the shaft slowly and gradually bringing it up to a red heat at the bend, at the same time easing up at the centers as the shaft expanded. After getting the shaft sufficiently hot I removed the forge and brought a 40-ton hydraulic jack, as shown, into place; I then put about 30 tons pressure on the shaft at this point, and upon releasing the jack the first time I found that I was ¼ inch nearer true than at the start. By putting pressure on with the jack several times I was within 3/64 inch of being true. I rotated the shaft until I found the lowest point, then put on 40-ton pressure and let it stand over night to cool off. On releasing the jack in the morning we found the shaft within 0.010 inch true.

By this means of straightening it takes all strain off of the lathe-centers, and it is possible to bring the shaft sufficiently true for all practical purposes.

E. Cooper Wills.

Boring Large Work on a Small Lathe.

An old 18-inch lathe was taken and a 1¾-inch hole bored through the spindle. The headstock of the lathe was reversed



A SMALL LATHE RIGGED UP FOR BORING LARGE WORK.

and extension pieces *C* bolted to the face plate to afford means for clamping large work.

A casting *A* was bolted to the carriage and a boring bar *B* made to fit the hole in the spindle. This bar carries a double-ended cutter *D* and is fed by the tool carriage.

With this rig we have bored chain wheels and gears nearly six feet in diameter and could handle even larger work if not too heavy for the machine to carry safely. W. Alton.

Why Mechanics Do Not Read.

When so much good material is at hand for self-instruction and existing conditions pave an easy way for the willing student, so that all have the opportunity of acquiring a good education in any branch of science or art, is it not strange that so small a percentage of the public takes advantage of it? In almost every town there is a library or reading room, and even if one cannot have access to either, there are books treating comprehensively on any desired topic which are considered authoritative, whose authors are the greatest thinkers on the subjects, and which can be bought for a nominal price. Periodicals are legion. Many are good ones, standards in their line, and treat exclusively on any subject on which one may want information. Yet our reading rooms and li-

braries are practically empty through the day, and in the evening are very poorly patronized, and those who are present prefer to play some game rather than do any reading. Our fathers would have jumped at the opportunities which we now enjoy (?), for they took advantage of all occasions, which were few and under adverse circumstances, to read upon the subjects in which they were interested. Strange that the present generation, with so many greater advantages, makes no use of its opportunity. Is it because these advantages are so common and knowledge so easily secured that they are so little appreciated? Is that which is difficult to attain prized the more because it is so, regardless of its intrinsic value? Is the sentiment universal which is expressed in Mark Twain's remark, "If prunes cost ten cents apiece they would be the greatest delicacy in the world?"

I am well acquainted with a young mechanic who had visited Washington, and was much impressed with the Congressional Library. He repeatedly stated that if he only had the opportunity of spending some time in that building, he would certainly take advantage of it, and read extensively along mechanical lines. He is now working in the Navy Yard at Washington, is off duty at three in the afternoon, and on Saturdays works only in the morning. He has been there nearly eighteen months, and according to his own statement, he has been in the library twice, the second time to take friends through who were visiting the city. Although he passes the library every day, all the technical knowledge which he has acquired is nil.

This brings me to my subject proper, one which I am sure will interest AMERICAN MACHINIST readers, and should interest those who, to their discredit, are not your readers. In looking over the back numbers of the paper my attention was arrested by a question asked by one of your correspondents, "Why do not more machinists read the mechanical papers?" As no answer was given, the impression was conveyed that many machinists do not read these papers. I concluded that a little investigation of my own might be for my own benefit, might give me some light on the subject, and incidentally prove interesting to others. I thought that the best means for securing the information would be to interview those mechanics who do not read and discover their reason for not doing so. So I proceeded accordingly.

One man whom I questioned is a good mechanic, has been working at the trade for 15 years, and although he holds a good job at the bench, his work is pretty much the same today that it has been since he served his time. He has been working at one branch of the trade so long that he considers himself an authority in his class of work, and is loath to accept suggestions or make experiments. One would naturally conclude that a man with this disposition has read very little along mechanical lines. When asked if he had ever considered subscribing to a technical journal, his answer was something like this:

"Yes, lots of agents have tried to talk me into it, and nearly every cub in the shop has tried to secure a commission out of me; but then their interests are not mine. Four dollars for a paper? Why, they must think me easy. A man in my position cannot afford anything like that."

Yet this man pays more than that for a daily paper and admits that he seldom gets farther than the head lines and cartoons. Perhaps the fifty cents monthly do not seem so great to him as the sum total. He smokes two five-cent cigars daily and will frequently "for friendship's sake" take a glass of liquor. He goes to every show that comes along and is on every excursion, often spending the subscription price objected to on one trip. He thus spends money needlessly which if summed up for the year would more than pay for half a dozen good journals. Yet he cannot or will not see his false economy, and positively contends that his circumstances are such that he cannot afford the journal. Admitted that his financial affairs are an entirely personal matter with him, yet that fact does not change the inconsistency of his position.

Another on being questioned replied that he did not have the time to read through a paper every week and so has given it little consideration. It is not unusual for this man to spend an evening at pool or billiards, playing continuously from seven until eleven. He is a single man with practically no responsibility outside of his work and his evenings and Sundays are open to spend as he sees fit.

Another claimed that much of the subject is too deep for him; there is much which he cannot understand. He admitted a fair knowledge of the lower branches of mathematics, including arithmetic, elementary algebra and a smattering of geometry and also that he had a clear conception of them so far as he had studied. He complained that many of the formulas and many of the data given in technical papers are entirely incomprehensible and that very many mathematical signs are as Greek. This man's inability to comprehend the articles which he mentions is due either to lack of application or inclination or both. His hobby is music and he has mastered the violin to the point of being an exceptional amateur. He is now studying harmony and counterpoint, conceded to be the most difficult of all theories and the one of which it is hardest to obtain a correct conception. If the opinion of those in a position to know is of value he has made excellent progress. Yet he professes his inability to understand the simple problems in the journals, and this in face of the fact that he has chosen mechanics as his life work and studies music for pleasure and pastime only. It is hard for me to conceive any logic which could support his position.

Still another made the rather remarkable statement that a fellow does not receive credit for schemes applied to his work which he has seen in the AMERICAN MACHINIST, for the reason that the men over him read also and discount accordingly his ability. This answer, while obviously incorrect, I believe deserves consideration. Some time ago I heard a very interesting argument on this question which brought out an excellent opinion on the subject. Several of the drawing-room force were debating over a jig problem, among them a technical graduate and an apprentice. The apprentice finally suggested a scheme which was adopted. After the controversy had ended the college man went to the head draftsman and depreciatingly informed him that the plan had been published in the columns of the AMERICAN MACHINIST. He received a response which brought the color to his face which was about as follows:

"Well, why didn't you suggest it then? Had you done so would you have given the AMERICAN MACHINIST the credit? If you had suggested something which you had learned at school you would not have informed me of the source of your information, and let me tell you that that young fellow's perusal of the AMERICAN MACHINIST is just as much his education as your college training is yours, and if he is quicker to apply it it amounts to just as much. You were both in that problem together, both had an equal chance, and you let him win out, and now you are trying to deprive him of the credit due him. I want it strictly understood that results are what count in this place and prestige from former environments, college or otherwise, will cut no figure if you cannot make good."

The above interviews are only a few of many and have been selected as representative. Many other answers were given which are so insignificant that they do not deserve attention. The fact that all seemed most willing, even eager to advance a reason was very evident. Their attitude was very like that of the small boy who has neglected an appointed duty and is trying to clear himself with excuses. Before approaching any of them I endeavored to pick out those who from general appearances and the trend of their work, I judged did not read technical journals. In every instance with but one exception my surmise was a correct one, for the fact that they were not progressive enough to read on their line of work was evident. After I had gone the round I reversed the order and went to all of the best men in the shop, from the superintendent down to the old reliable standbys in the tool room and on the bench. The result was that all (no exceptions here) were readers of the AMERICAN MACHINIST and some of them were getting two or three mechanical journals.

With these facts so evident, surely there should be some incentive for the mechanic to constantly add to his store of knowledge and increase his efficiency by investing in literature dealing directly with his work. I believe that if anyone, no matter where located, will take the trouble to investigate he will find that those who have reached the top have been constant readers. There seems to be a mistaken notion prevalent that the reading is the result rather than the cause of the reader's promotion. Careful thought and study will surely prove the reverse to be true. The young man with only a common-school education who has had practical experience and has been a constant reader has, in our shops, forged ahead of the college graduate who considers his education finished and does not read. After all, the college man has only a little better beginning than the apprentice and even this has been disputed, for practical experience is the fundamental base of mechanical success. All of our most important technical schools are learning from the shops rather than the shops from the schools.

Conditions as I see them lead me to believe that the best mechanical education is a combination of thorough practical experience, association with superiors in one's occupation, diligent research in literature both standard and current and a comprehension of those mathematics which deal directly with mechanics. These any ambitious young man may secure with little expense. Money is not the chief requisite, but persistence and application.

One young fellow upon being cited to another, who had risen above him, as evidence of the value of trade literature, replied, "Oh, Sam? Well, no wonder, he has a pull; the old man thinks that there is no one like Sam." Admitted, but I know personally that Sam got that pull only because he proved to be a good man and is interested in his work. He is diligent, persistent and applies himself with an ardor which shows that his interest is wholly in his work for the work's sake rather than personal gain. Any man can gain the same pull by following a similar course. The only question which he has to decide is whether the result is worth the effort. I have been asked the question whether the fact alone that a fellow reads mechanical journals gives him prestige. Within my observation it does. One of our foremen answered that the man who is sufficiently interested in his work to invest in a subscription and spend a portion of his time in reading has invariably a better prospect than the one who does not; and he will get a better "show," for he is entitled to it and is better able to fill a good position. He added, however, that he would not tell his men that, for if he did some of them would subscribe at once expecting in a month to be in line for the best job in the shop.

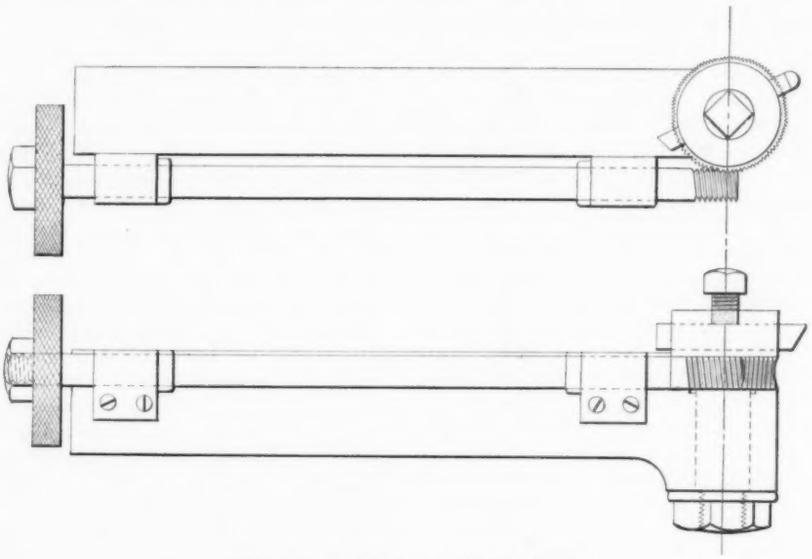
With all the evidence proving the great educational value of mechanical literature and the fact that this literature can be secured for so little money, yet the great majority of the men engaged in mechanical lines neglect the opportunity and prefer to spend both time and money for something which brings them no return. Certain it is that very many men with the stuff in them to reach the top, or at least go far up the ladder, fail because of their constantly neglected opportunity.

PESSIMIST.

Tool for Machining Large Fillets.

I enclose two sketches of a fillet turning or planing tool, which I believe excels the one which appeared at page 156, contributed by J. Menegus. It does away with the offset, which is a prominent feature of Mr. Menegus' tool, and it can be used on a complete half-circle directly in front.

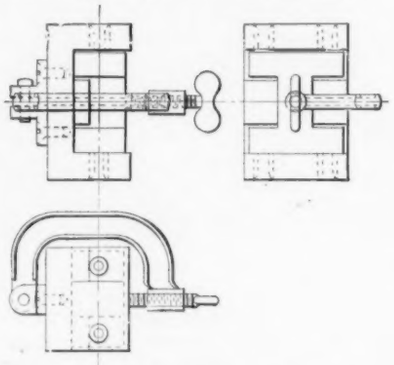
Washington, D. C. BURT SKELLAN.



TOOL FOR MACHINING LARGE FILLETS.

A Clamp Hinged to a Drill Jig.

The sketch shows an ordinary malleable iron clamp hinged to a drilling jig.



A CLAMP HINGED TO A DRILL JIG.

I was using a jig like this, but the clamp was not hinged to the jig, and every time I unscrewed the clamp I had to take it off, lay it on the drill-press table, take the drilled casting out of the jig and put a blank in. I would then pick up the clamp, which by this time was generally on the floor, and clamp the casting in the jig. I soon got tired of this performance and hinged the clamp to the jig.

C. W. J.

A Boy's Objections to Serving an Apprenticeship.

I have read with interest the article at page 25, A Boy's Objections to Serving an Apprenticeship, by Pessimist, and would like to take up some of his points from the standpoint of one who has been through the mill and is now bringing others through.

1st. "That the factories look entirely to their own interests to the detriment of the boy and do not advance him as rapidly as they should." Speaking of mastering one branch and then being kept at it, who is to be the judge of the mastery? Does the apprentice expect to pick his own jobs and dictate as to what he is to do? In my experience, a boy does not master any branch of the trade in his three or four years' term, and I believe that the average boy is moved around as often as he deserves.

2d. As to the "opportunity for an all-around experience." What is wanted is to make an expert man in some one trade and not a "Jack of all trades." I believe that life is too short to try to cover the whole field. However, we do have our patternmaker apprentices serve six months in the foundry in order to give them "foundry sense."

As to the special fixtures, jigs, etc., it does sometimes get monotonous to do this repetition work, but if the boy is bright, and progresses as he should, he is soon learning to make these fixtures, which is certainly good work. We rarely find apprentices employed as machine ten-

ders, but this work is given to specialists who are employed for that purpose only and not to learn the trade.

3d. "The associations are bad." I object most strenuously to this statement, and it could only have been made by one of very limited experience and knowledge. I was raised on a farm; worked for twelve years in machine shops and drafting rooms; traveled in various parts of the country in a way that brought me in contact with many classes of men, farmers, dealers, manufacturers, mechanical engineers, traveling men, railroad men, etc., and I say most emphatically that the shop men do not suffer at all in comparison with the other classes. In the disclosures of rascality, filth, and corruption in the papers, I do not find any great preponderance of machinists. No matter where you will go, you will find human nature much the same, and you will also find vulgar, foul-mouthed men.

4th. "The environment is not conducive to good health." There is no doubt that there are shops, as well as offices, homes, stores, etc., where the sanitary conditions are bad, but the modern shops, and many of them not so modern, have everything necessary for the workmen's comfort. The pages of the AMERICAN MACHINIST as well as other technical journals show that conditions are being bettered all of the time and are incomparably better than in the "good old times."

5th. As to the "injustice of foremen," it should be remembered that foremen are only human and if the boys could only look at things through the foremen's eyes for a time, they would wonder how he could treat them as well as he does. I often wonder when I look back why my foreman, during my apprenticeship days, did not kick me out of the shop, although I used to think I was badly abused.

6th. As to "the union," I do not think that this point is well taken, as if he does not want to work under union conditions, there are a large number of open shops where union and non-union men work together in harmony.

7th. As to the "difficulty of getting bright boys to learn the trade," in this section of the country the supply always exceeds the demand. I had to wait about two years for a chance, and then had to bring some "influence" to bear in order to get in. All of the shops around here have applications from far more boys than they can possibly use, and while they are not all the brightest, they are not all the dullest by any means, but just good, average boys.

There were two principal reasons which decided me in favor of serving an apprenticeship in a machine shop: First, I liked the work and my tastes ran in that direction, and second, I considered it one of the most promising fields for a young man and one that offered the greatest chances for advancement. I have never had occasion to regret my choice.

W. P. HUNT.

Forging a Copper Ring.

A number of large copper rings were required by an electrical concern. These were cast in the brass foundry but after testing were found useless for their purpose so the job was given to the forge to make them from the solid to the figures given on Fig. 1.

The method the foreman of the forge used to determine the amount and size of stock to make them from, and also the make-shift tools to form the rings will no doubt interest your readers who are acquainted with the forge and may have run up against a similar job. The foreman had as auxiliary to his mental equipment a slide rule, for which he found frequent use as many small calculations had to be made daily in the forge to determine sizes of stock and weights of forgings. He proceeded something like this: The section of the ring had to be 2x2 inches when finished, so allowing 3/16 in. for machining on all sides, the section to be forged measured $2\frac{3}{8} \times 2\frac{3}{8}$ in.

First, the volume of the ring was figured as follows:

$2\frac{3}{8} \times 2\frac{3}{8} \times$ mean diameter $\times \pi =$ volume of ring in cubic inches.

$2.375 \times 2.375 \times 3.1416 =$ say 284 cubic inches.

Fig. 2 shows the blank ready for expanding. A hole is punched out in the center and of course that is so much more waste. The punch was about 2 inches diameter at the small end and the blank 4 inches thick, so that the waste due to the hole was

$$\frac{2^2 \times 3.1416 \times 4}{4} = 12.57;$$ say, 13 cubic inches.

So that there were 284 cubic inches for the forged ring itself;
13 cubic inches for the hole punched out;

which gave altogether 297 cubic inches for the amount of material used in making the ring.

A copper billet 6 inches square was decided upon as being a good forging size, therefore the length required to forge one ring was $\frac{297}{6 \times 6} = 8\frac{1}{4}$ inches. As there were 6 of these rings to make, the billet was ordered 50 inches long. The process of forging one of those rings was as follows:

The billet was marked while cold into six equal lengths, then placed in a reverberatory furnace and heated for about 12 inches. The first section was cut off and beaten down to the shape shown in Fig. 2 under a 4000-pound steam hammer, the hole also being punched out. This constituted the first heat. The second heat consisted in working out the ring to the required diameter and section.

A block, Fig. 4, made from a steel casting was fixed in the seat of the hammer; the blank was drifted out until the forging mandrel could enter far enough to work the blank (See Fig. 5) around in the V's as seen in Fig. 4, the mandrel being rotated and gradually pushed in as at Fig. 3. The breadth of the ring naturally increased, and when this became excessive it was flattened down on top of the block at *A*.

When the ring was getting near the forging size the segment tools Fig. 6, were used which formed the ring to correct diameter all around. The tedious part in the series of operations was in having to transfer the ring to the top of the block to flatten it down when the breadth became excessive.

Perhaps some reader knows of a method of rolling or otherwise—*which has been successful*—whereby these blanks are reduced to the finished ring in one operation; that is, expanding the ring and flattening it down at the same time.

Many steel rings were afterward made in the same way, a number being gear blanks which were shrunk on to cast-iron

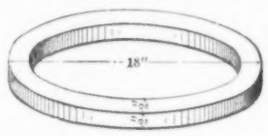


FIG. 1. Finished Ring

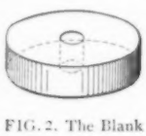


FIG. 2. The Blank

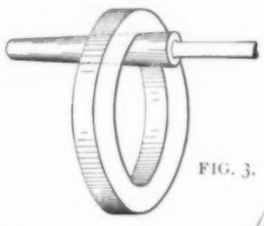


FIG. 3.

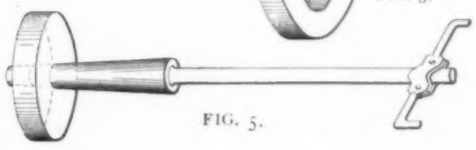


FIG. 5.

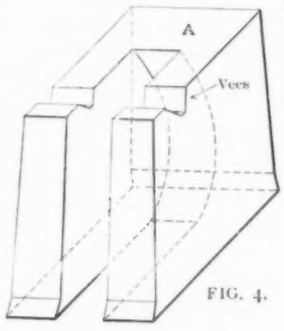


FIG. 4.

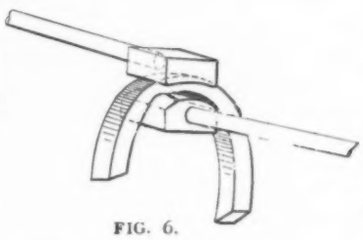


FIG. 6.

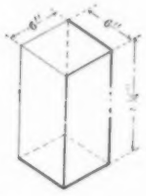


FIG. 7. The Stock

FORGING A COPPER RING.

hubs, to replace faulty gears made from steel castings.

In these days of progress much has been done to help the smith at his work; the smith has responded and helped himself along. I have known a number of smiths well posted in technical matters relating to their branch of industry. In looking over a small hand-book possessed by one of those men, I found the two following easy methods of calculating the approximate weights of round and rectangular steel sections respectively. These will interest many readers as they are not generally known.

To find the weight of any round section: Square the diameter in quarters of an inch and divide by 6 gives pounds per foot.

Example: Find the weight of a bar 1¾ diameter. Reducing it to quarters of an inch, we have 7.

$$\frac{7 \times 7}{6} = \frac{49}{6} = 8\tfrac{1}{6} \text{ pounds per foot}$$

For square and rectangular sections multiply the thickness by the breadth and multiply by the constant 10, which gives the weight per yard.

Example: Find the weight of a section $2 \times 1\frac{1}{2}$ inches.

$2 \times 1\frac{1}{2} \times 10 = 30$ pounds per yard.

A. SMITH.

Minimizing Shrinkage Stresses in Balance Wheels — Reply to Criticism of Mr. Osborne.

The readers of Mr. Osborne's criticism at page 27 of my article at page 742, Vol. 29, Part 2, will note that his method of cooling a *similar* balance wheel differs from mine only in that he uses *green* sand instead of *dry* sand—see paragraph eight. He saves from 10 to 20 cents on the cost of each wheel the rough-casting value of which is about $70, and he is by no means as sure of getting a sound wheel. Moreover his shrinkage stresses have *not* been reduced to a minimum.

If I was too severe in my criticism of the old foundry method of cooling pulleys by stripping both hub and rim it was unintentional. We all know this method has been in successful practice for many years with pulleys of usual design. The trouble is that the ordinary foundry man will employ the same method on wheels of all designs. I was dealing with a particular case of a balance wheel with heavy rim, heavy hub and light arms. When these wheels are allowed to cool in the manner suggested by Mr. Osborne (that is by covering with green sand) a large portion of the heat contained in the casting is conducted away by the wet sand surrounding the wheel and there is not maintained a uniform reduction in temperature throughout the mass, a condition which is more nearly approached by insulating the casting and forcing the heat initially contained in the rim to pass through the arms and keep them at practically the same temperature as the rim and hub at all times. The same principle could be applied to any casting consisting of relatively large and small masses; that is, make use of the heat in the large mass to keep up the temperature of the small mass while the casting is cooling.

By the method described I claim:

1st. A wheel is obtained of minimum shrinkage stresses in the arms.

2d. The iron ordinarily used in the foundry for castings of similar weight can be used, making unnecessary a special mixture in order to reduce shrinkage.

3d. A standard method of cooling, such as this, requiring practically no skill is far better in every way than one depending upon the skill of the foreman or the man who makes the wheels. This will develop very quickly if it becomes necessary to change your men for any reason.

The objections are:

1st. A slightly increased cost for handling the wheels. Two laborers with the assistance of a crane take these wheels out of the sand and place them on the annealing bed in about ten minutes. They are covered with dry core sand in about the same time. All this is done near the end of the heat, at a time when a portion of the common labor force is otherwise idle. As a matter of fact there has not been noticed any increase in the labor cost on account of annealing these wheels.

2d. Foundry floor space is required for annealing. This would be an important factor in many cases, but is of no consequence in the particular case referred to since the foundry has floor room to spare.

3d. Delay in delivery of wheels to machine department.

I object to the statement made in the last paragraph of Mr. Osborne's criticism in which he says that "it is easy to see . . . . that the arms of the flywheels are in compression." I have *seen* so many of them pull apart that I know that this is *not* the case; especially with the particular wheels referred to. In making this assumption he has overlooked the well known fact that thin castings shrink more than heavy castings and that the arms of this wheel being much thinner than the rim will have a greater shrinkage coefficient. I am not prepared to say, however, that the annealing process makes these coefficients more nearly equal, although I believe it is conceded that the total shrinkage is reduced.

I have called the attention of a friend to this criticism and he writes me as follows:

"I have read the articles in the AMERICAN MACHINIST to which you call my attention. Everyone seems to agree that the correct theory requires an equalization of the time set for the iron throughout all parts of the wheel, but the doctors do not seem to agree as to the proper way of accomplishing this. In the particular case of the balance wheel shown, it seems to me that your critic does not make his theory and his practice agree. He says that 'if the arms are of heavy section compared with the rim, to keep the rim, as well as the arms, covered.' The inference from this, I should think, is that if the arms are of light section as compared to the section of the rim, it would be necessary to uncover the rim and hub; and keep the arms covered. Yet your critic says that in the case of this particular wheel, his idea would be to uncover the center of the hub and dig out the core, and allow the wheel to remain covered, yet I should think this wheel is a fair representative of heavy rim as compared to spokes. In fact, a much heavier rim than this spoke section would make a badly proportioned wheel. He further says 'If these sizes are approximately right, it would not be wise to cool off both hub and rim so as to have them set solid first.' This is certainly a very wise observation inasmuch as the principle in the first place is to have all parts set uniformly at the same time, and I don't suppose anybody would suggest any advantage in having the rim and hub set solid before the spokes do; but the point is whether it would be necessary, with a rim as relatively heavy as this one, to uncover the rim to make it set solid as soon as the spokes set solid. At any rate, if this is not the place in which to uncover the rim, it is hard for me to see when it would be proper to uncover the rim."

GEO. F. MADDOCK.

Homemade Boring-Mill Rig for Spiral Work.

Some time ago I was in a shop when they got an order for several 10-foot drums about 20 feet long and having a spiral groove for about 1½-inch rope about 2-inch pitch. They were to be made in three sections and bolted together inside, the end sections to hold the spiders and hubs.

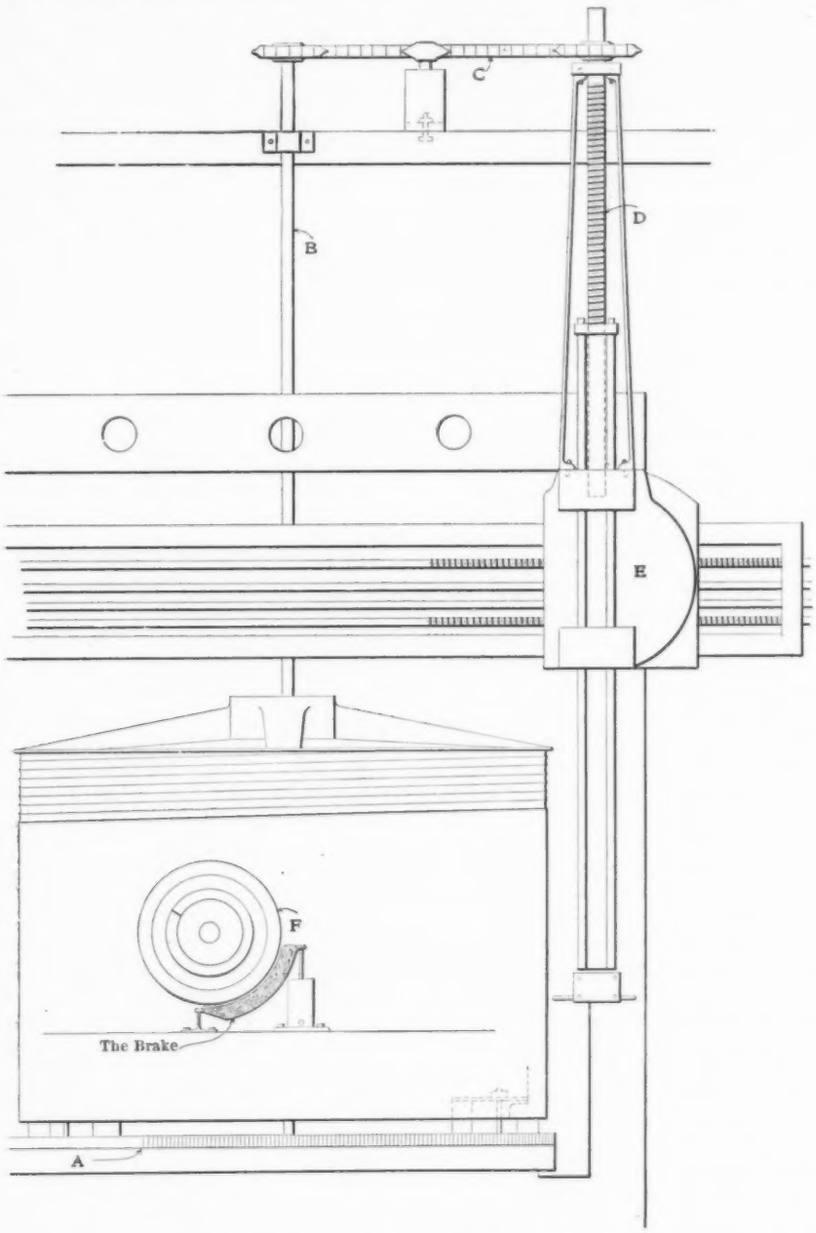
The mill was a Niles, 10x16-foot friction-feed pattern, and although the right pitch could be obtained, there was great danger of slipping, so a positive feed was devised. A large circular gear rack *A* was cast a loose fit—rough—to the outside diameter of the table and securely fastened to it with screws, babbitt being poured in to fill up spaces and make everything tight. This drove a vertical shaft *B* at the back, which in turn drove by the chain *C* a specially cut lead screw *D* directly attached to the head *E*. The head was of course disengaged from all feeds except the cross. It worked O. K., but a great objection was that the whole thing had to be run backward to start another cut, and as this took nine minutes, it was no mean item.

A friction air brake *F* was attached to the machine's countershaft cone pulley, with a lever at operator's hand, enabling him to stop within about two inches in

case of the chain breaking, etc. This came in handy several times.

It consisted of a wooden block cut the same curve as the pulley, and having a bearing for about 1½ feet; it was leather faced, and backed by a strip of ¼-inch wrought iron. A 3-inch brass tube between one and two feet in length, fitted with a base, a piston and a cap, and about 70 pounds of air pressure, supplied the necessary shove. The brake shoe was hinged on the floor (the counter shaft was down there), the other end being directly connected to the piston rod. Turning on the air caused the shoe to attempt the job of tearing the whole countershaft up by the roots. The entire job required no little skill, as the grooves had to be started in the right place to correspond with the lugs cast inside for bolting.

Canada. W. L. McL.



HOMEMADE BORING-MILL RIG FOR SPECIAL WORK.

"Rotating a Shaft 180 Degrees Without a Dead Center."

It seems to me that some designers writing about the above subject have gone to a great deal of trouble in working out schemes with levers and arms to accomplish this result.

As I remember the proposition at page 123, Vol. 28, or at page 125, Vol. 29, there is a shaft to be revolved 180 degrees and an actuating rod moving in a straight line, nothing being specified about using levers. This being the case, why not use a rack and segment of a gear, or a plain pulley, a straight rod and a flexible steel cable passed around the pulley and its ends fastened to the ends of the rod? There is nothing new in these ideas, still it seems strange that they were not used.

The writer, of course, is not aware of the conditions under which the lever schemes were worked out, but it does seem as if one or the other of these two methods mentioned would be just as reliable, as cheap to manufacture, and not take up as much room as the lever arrangements. ERNEST J. LEES.

Cleveland, O.

Legal Notes.

BY E. P. BUFFET.

A GEAR WHEEL THAT EMITTED FLYING SPARKS AND A SCREECHING NOISE.

A brick molder was injured by the rupture of an 8-foot crown "cog wheel," which drove a breaking and grinding pan near which he was working. He testified that he had previously noticed that it was emitting sparks and making a screeching noise, and had called the attention of the superintendent to this fact, but was encouraged to go on with his work.

Upon bringing an action, the jury awarded damages to the molder, and as the case comes up to the Pennsylvania Supreme Court for review, the question arises whether the circumstances shown in the trial furnished ground for submitting any question to the jury, or whether the court should not have ordered a verdict for the brick company. The company had offered evidence as to the apparent good condition of the wheel, and had shown without contradiction that the sparks were sometimes caused by cutting of the grease by gritty substances, so that this fact alone need not have denoted a dangerous condition. The appeal court holds that if the phenomenon of sparks had been the only one, there would have been no reason for submitting the case to the jury. The screeching noise, however, had not been so satisfactorily explained. This, coupled with evidence that the sparking had been so excessive as to indicate something worse than grit, and with perhaps certain other factors involved in the case, furnishes, in the court's opinion, ground on which the submission to the jury can be sustained. Judgment for the molder has therefore been affirmed.

63 Atl. Rep., 692.

In accordance with the modern practice of reducing the danger of fire in electrically-propelled trains in tunnels to a minimum, it is stated that the Pennsylvania Railroad will provide complete steel passenger equipment, including mail cars and sleepers as well as day coaches, for all through and local trains which will enter the New York tunnel. The steel car has been for several years well established in freight service, especially in the coal traffic, and its development for passenger service may be expected to proceed very rapidly. Even the surface electric lines have been experimenting with it to some extent.

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Our Study of Space.

Usually very heavy machines are constructed for doing heavy work, and when doing this work are much more heavily loaded than when running idle. Not so, however, with the machine which is the subject of the initial article of this issue. It has nothing to do when at work except to move itself, and when in full use there is no more pressure or stress upon its various bearings, gears, etc., than when being idly moved. Its work consists in directing an intangible line of collimation toward a distant star or planet, and in keeping it there, notwithstanding the motion of the earth and of the body under observation.

Could an observer standing apart from the earth see this, to us, gigantic instrument, and the base upon which it rests, he would see a ball which, when compared with others about it on all sides, would appear very small and insignificant, whirling like a top with a surface velocity at the equator of over 17 miles per minute, while at the same time moving through space in the path of an ellipse at the rate of over 550 miles a minute. On this ball would be seen the astronomer with his machine spy glass, now in the light and now in the darkness, attempting to gather facts which may ultimately contribute to a knowedge of our final destination.

If one holds a small telescope in his hands, and gazes through it at a star, he unconsciously moves the telescope to keep it directed upon the star, and the angle at which it must be inclined changes about 15 degrees per hour. The clock of an equatorial telescope, which has no escapement, which would allow only an intermittent motion of the wheel train, does the same thing, only with the greatest possible accuracy—such accuracy indeed that a photographic plate attached to the telescope and exposed for hours will show stars clearly and sharply defined.

Among those whose souls never rise above bread and potatoes, it is the fashion to rather despise the work of the astronomer as "useless star-gazing." Aside from the great service it has rendered and is rendering to navigation, and to the keeping of exact time for our railroads, etc., it is constantly gathering a mass of facts which at any time may be coördinated with other facts, and go far toward solving the great mysteries which men have sought to solve since they first looked upward to the stars. And thus though the machinery we illustrate carries no tangible load, the most momentous things may depend upon it and upon its precise performance of the tasks for which it was designed.

There is no up or down in space. Our little sphere, rotating upon its own axis, revolving about the sun, and at the same time probably moving through space, with the sun, about some greater and unknown central body, is surrounded on all sides by the impenetrable mysteries of illimitable space. Telescopes, transits, spectroscopes and the other paraphernalia of astronomical observatories are, so far, man's best means of obtaining at least some little knowledge of this space, and of what it may contain. One thing that it certainly does contain is a lesson on the comparative insignificance of most of those things which we are in the habit of regarding as of supreme importance.

The Pack-Saddle on Wheels.

Schemes for the construction of railways so that the center of gravity of the rolling stock comes below the rails have been cropping up in one form or another for many years. These systems are often called monorail, because nominally there is but a single rail used to support the rolling stock, which latter is divided and hangs on either side of the track; but what with guard rails, safety rails, holding-down rails, etc., etc., some of these designs have seven or more rails instead of one, not to speak of the more or less elaborate framework upon which all this rigging is carried.

John Langdon Sullivan, born in Maine in 1777, an inventor and civil engineer, and afterward a practitioner in medicine and surgery, in 1827 published a pamphlet with details of a plan of this nature which he had invented, and in which two rails were laid close together, a few feet above the ground. The wheels which run on them support yokes, from the ends of which were to be suspended the twin car bodies. The motive power proposed was horses, although one of his cross-sections showed the car body on each side carrying a boiler and vertical steam engine, with cranks on the end of the axle. Mr. Sullivan thought it would be well if the Baltimore & Ohio railroad, which was then projected, should be constructed on this system, so that the cars might be elevated above the winter snows in the Allegheny mountains and the spring mud in the lower districts. It is evident that the Department of Maintenance of Way at that time must have been an undiscovered germ.

Two recent developments in this country call attention to the "straddle railway." One is the construction of the Baltimore & Ocean City Railway, which is shortly to begin, according to the "monorail" system, so as to enable Maryland's principal seashore resort to be reached from Baltimore in less than two hours, the distance being 113 miles; but there is required about three-quarters of an hour to cross the Chesapeake bay by steamboat to Tolchester. The way (one can scarcely say road) will be run from there in a pretty straight line across the Maryland-Delaware peninsula, without grade-crossings, and it is said that the trains can safely maintain a speed of 100 miles an hour.

Another scheme is the proposition of

the newly organized "Real Rapid-Transit Association of Brooklyn" to build a Behr "monorail" line from the Williamsburgh Bridge to Coney Island, and then back to the Brooklyn terminus of the Interborough Subway, this line to be partly subway and partly elevated. "A mile a minute" is the speed laid out for these trains.

In accordance with an arrangement which has been pending for some time, it is announced that the Link-Belt Machinery Company, of Chicago, has purchased the plant and business of its associate companies, the Link-Belt Engineering Company, of Philadelphia, and the Eward Manufacturing Company, of Indianapolis, and the entire business will be combined and operated under the name of the Link-Belt Company.

Submarine Signaling.

BY HENRY R. GILSON.

Tradition asserts that in 1826 Colladon & Sturm rang a small bell beneath the surface of the water of Lake Geneva, and heard its notes across the widest part, a distance of eight miles, the sound being transmitted in the water at a rate of 4700 feet per minute, and carried from the water to the ear in a tube not unlike a powder horn.

Sixty years passed, and then Prof. L. I. Blake, of Kansas, discovered that oar blades struck together beneath the surface of the water half a mile away were distinctly audible within the hull of the old "Constitution," whose sides were twenty inches thick. Nothing was done, however, to utilize this most important discovery as an aid to lessen the dangers of the sea until 1898, when A. J. Mundy, of Boston, in connection with the Gray Telephone Company, made several important discoveries along this line.

At the present time the system has been perfected to such an extent that bells are rung suspended 25 feet under water from light vessels; mounted upon the bottom of the ocean to mark dangerous shoals and rung from the shore by electricity; or attached to the bottom of buoys, and operated by the energy of the waves. Vessels are equipped with ears (telephonic apparatus in the hold), and are able to hear these bells ringing in the roughest weather at distances ranging from four to twelve miles, and, furthermore, are able to locate their direction within one-quarter of a point of the compass.

Collisions at sea may be avoided by each vessel ringing a bell in the bow below the water line, the sound being picked up by the approaching boat, whose course is varied in response to the signal. In experiments conducted at Newport, R. I., the approach and location of a submarine torpedo boat have been determined at a distance of two miles by hearing the noise of its machinery. The possibilities of this system in warfare are thus apparent. It is not affected by wind, waves, or any atmospheric condition whatever, all signals being transmitted in a homogeneous medium—water. The vagaries and unreliability of air sound-signals are so well known that this invention of the new-born century bids fair to become soon an important factor in the seafaring world of this and other countries for the safeguarding of lives and property at sea.

The Master Blacksmiths' Convention.

The Fourteenth Annual Convention of the International Railroad Master Blacksmiths' Association will convene at the Sherman House, Randolph and Clark streets, Chicago, Ill., at 10 o'clock a. m., August 21, 1906, and remain in session for three days. It is expected that this will be a very interesting and profitable meeting. All motive-power officials and foremen blacksmiths are cordially invited to attend, whether members of the association or not.

The following is a list of the subjects to be discussed: Frogs and Crossings; Flue Welding—Best Method of Fine Welding and Flue Used; Classification of Work in Shop; Tools and Formers for Bulldozers, Steam Hammers and Forging Machines; Discipline, and How to Obtain the Best Results in a Railroad Blacksmith Shop; Case-Hardening Methods—Time Taken and Specimens of Work Furnished, and Kind of Material Used; Best Method of Annealing High Speed Steel, also of Tempering Same; Best Coal for Use in Smith Shop and Kind of Fires Used; Subjects for 1907 Meeting; Piece Work vs. Day Work; Making of Locomotive Frames—From Scrap to Finish; Also Repairing. How Many Broken During the Year; How Often Broken in Same Place; Thermit Welding and Cast.

The president of the association is D. B. Swinton, Montreal, Can., and A. I. Woodworth, Lima, O., is secretary-treasurer.

In an article on the compass machine, by V. H. Claudy, at page 1, he refers to the inventor of the machine as "A man described by those who know him as rather uneducated and unlettered, but a genius at applied mechanics." We learn that this is an entirely mistaken statement, as the inventor of the machine, V. Le Comte Ourdan, holds the degree of LL.B. from Georgetown University and has command of several languages; so that, therefore, it is anything but correct to describe him as being uneducated and unlettered.

The New York Central is getting its third rail laid, and has received two of its electric locomotives, and made trial runs between Highbridge and Kingsbridge, New York City; the Port Morris power house is partly in operation.

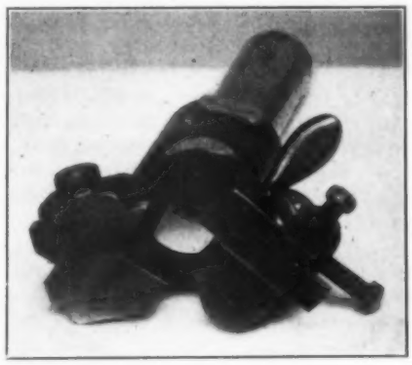
New Tools and Machine Shop Appliances.

NEW CLAMP.

The Bay State Tool Company, of Worcester, Mass., has brought out a new clamp, which is called the Lightning clamp, this name being chosen for the reason that they employ an eccentric nut by means of which, and by the movement of a small lever, the screw is released and passes readily through the clamp until it comes in contact with the work, when a turn of the small lever again engages the nut with the screw and the latter is then tightened in the ordinary way. This adds very much to the facility with which the clamp can be applied to work of varying dimensions.

A FINISHING BOX TOOL.

The illustration shows a box tool, for use in the ordinary turret, which possesses the advantages of the rocking tools used on flat and hollow hexagon turret lathes. By using a tangent tool it is a free and rapid cutter. The steady jaws are adjustable, they have a burnishing effect and produce smooth work. The



FINISHING BOX-TOOL.

rocking tool holder controlled by cam handles permits the cutting edge to be cleared from contact with the finished work on the return, while the machine is running, and thus avoids marking the work.

The rocking construction permits work to be turned smaller for a certain distance between the ends. The cutting tool can be set to precede or to follow the steady jaws, and can therefore be used on rough stock as well as on cold rolled material.

This tool is made in several sizes to turn up to 2 inches diameter and 4 inches long by The Garvin Machine Company, New York City.

The Metropolitan Steamship Company is having built at Roach's shipyard at Chester, Penn., on the Delaware river, two turbine steamships for the passenger trade between New York and Boston, to be named the "Yale" and the "Harvard." The steam turbines are to be built by W. & A. Fletcher, of Hoboken.

The Action of Capped Armour-Piercing Shell.*

BY EUGEN KODAR V. THURNWERTH.

Among the most notable of the recent achievements in artillery, especially in connection with the effect of the projectile on the target, is the increased penetration that has been attained with armour-piercing shell by the application of a cap to the projectile. It is proposed in the following paper to examine briefly the reasons for this superiority of the capped projectile.

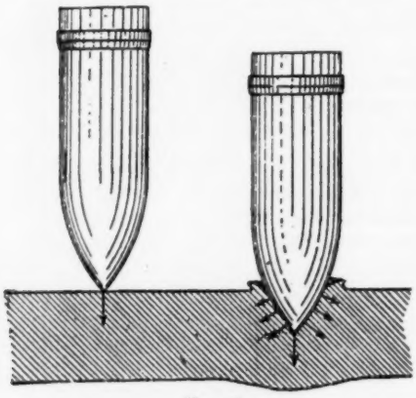


FIG. 1

There has been waging an incessant contest between armour and artillery since the fifties of the last century, when wrought-iron plates were first used as armour, which kept out completely the cast-iron balls of the smooth bores of the period. In this struggle of armour against artillery, now one and now the other has been ahead, and despite the fact that the dead material seems to have been worked to its utmost limit, there does not yet appear to have been any pause in the competition.

The latest achievement in the domain of armour was the general introduction, since 1890, of Krupp cemented and hardened nickel-chrome steel; with this step, armour apparently rendered nugatory the action of the projectile. Though good K.C. plates were not impenetrable to a good projectile of corresponding size, yet the inevitable shattering of the projectile seriously reduced its effect, or made it altogether ineffectual. But the armour-plate did not hold its victory long; hardly three years had elapsed after the astonishing results of these armour tests were known, before there appeared the still more wonderful news of the action of capped projectiles, whose overwhelming attack defeated the strongest Krupp plates. So with the general introduction of capped projectiles the artillery has acquired a superiority, within certain limits, until something further develops.

The relative superiority of armour or projectile is generally determined by the fact whether plates as thick as the calibre of the projectile can or cannot be penetrated at short fighting ranges. For example, a 6 in. armour-piercing shell, weighing 100 lbs., cannot pierce a 6 in. K.C. plate at 550 yards; but this shell would penetrate with ease a plate of equal thickness of unhardened nickel steel even at 3,300 yards. In the former case, we speak of the armour as superior to the projectile; in the latter case of the projectile as superior to the armour. With this standard, capped projectiles are superior to the best armour-plate, for at short ranges with correspondingly large striking velocity they penetrate plates of 1½ and even 2 calibres thickness. The literature on this projectile, which is now used in nearly all countries, is fairly copious, and most of the writers are agreed that at present adequate protection against this projectile must be sought by increasing the thickness of the armour, or in increasing the fighting ranges. The reasons for the superiority of the capped projectile over the uncapped are often not discussed

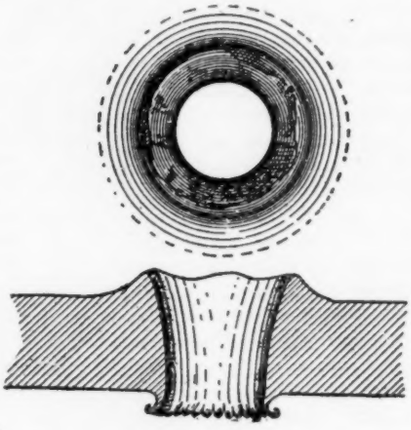


FIG. 2

at all, generally they are touched upon in a superficial way, and the explanations offered fail to satisfy the requirements of even an elementary theory.

Perhaps the most widespread explanation is, that the material of the cap acts as a lubricant for the projectile in its passage through the plate, and reduces the great amount of friction that occurs between the surface of the projectile and the plate opening. Were it indeed true that the action of the cap lay in nothing else than this, the advantage would hold only in the case of soft plates, where the head and body of the projectile both come into sliding contact with the plate opening, and an advantage would not be found with hard plates where there is not sliding contact between plate and projectile. Now, all experiments show that the superiority of the capped projectile is unquestionable only with hardened plates, whereas with soft plates the capped projectile is not better than the uncapped.

Against the hypothesis that the cap serves as a lubricant, there also stands the consideration of the great quantity of energy that would have to be spent in heating and melting the cap, which energy being drawn from the projectile would be lost for its especial work of penetration. In the tests of the Royal Naval Committee (Austrian) the weight of a cap of a 12 cm. armour-piercing shell (4.7 in.) was about 1.5 kg. (3.3 lbs.). To heat this mass to the melting point would require $1.5 \times 0.1165 \times 1,400$, or 245 calories, and to effect the melting itself would require about 50 calories more; this would be equivalent to a loss of energy of about 124 metre-tons. Yet in some of the tests capped projectiles with about 376 m.t. striking energy have not only gone clean through the plate attacked, but have gone through a butt 4 m. thick and travelled 300 or 400 m. beyond. This result would be simply impossible if 33 per cent. of the striking energy were consumed in melting the cap. Uncapped projectiles fired under like conditions broke into fragments against the plate, in spite of the fact of having to their advantage this 33 per cent. of energy.

It must be admitted that around the point of impact very remarkable heating effects are often noticeable, the vicinity of the opening in the plate and the shell fragments showing yellow to blue tempering colors. This points to a heating up to 300° C., but this is a good way from a melting point of 1,400° C.

A second widely-accepted hypothesis holds that the cap takes up the first shock that occurs on the impact of the projectile, pretty much in the same way as a buffer of a railway car takes up the blow when one car meets another. In more precise

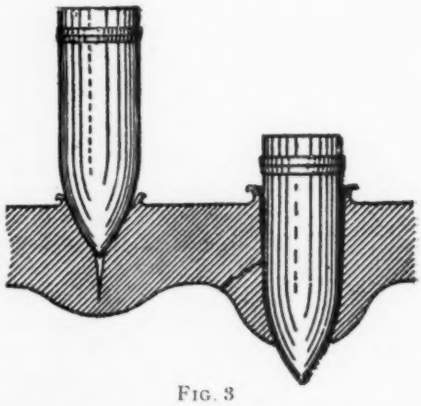


FIG. 3

terms this theory would run: The cap takes up that amount of energy which would cause the destruction of the projectile, and lets free only that part which is necessary to penetrate. But this leaves out of account the relation between the weight of the projectile and the weight of the cap, and in view of the great amount of energy present, this omission cannot be justified. By the theory of strains the cap could take up but a small amount of energy, still further reduced on account of

* Translated from the German as published in "Mittellungen aus dem Gebiete des Seewesens," by Captain George Blakely, Artillery Corps, U. S. A., and printed in the "Journal of the United States Artillery."

the inferior material of the cap compared with that of the projectile, without having its molecular structure destroyed Yet it is just in connection with great energy and high velocity that capped projectiles are most effective.

Another explanation is connected with the following illustration: A needle cannot be thrust through a board without deformation; yet if the needle is first set in a cork stopper so that it cannot bend, this can easily be accomplished.

Now, the small lump of metal on the end of the projectile cannot be regarded as the guide of the shot, especially because, as we shall soon see, it has become completely deformed when the projectile

FIG. 4

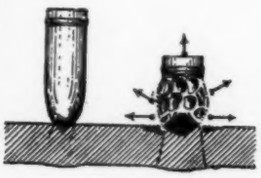


FIG. 5

stands most in need of guidance, that is when the point is piercing the hard armour plate.

The theory that the uppermost layer of the armour is softened and the plate so transformed into a homogeneous steel plate has very much more probability than any of the explanations so far adduced. It is very likely that a molecular change does take place in the plate under the combined influence of the great temperature and the violent concussion of impact. The only question is whether the short space of time is adequate for such a change.

To obtain now an explanation that avoids all these defects, and accounts for the superiority of the capped projectile in a purely mechanical way, let us proceed inductively, and figure in our mind the separate phases that occur during the penetration of various kinds of armour by hardened projectiles. Right here we shall see the essential difference that characterizes the penetration of hard and soft plates. With very soft plates, like wrought-iron, it needs but a moderate pressure at the point of impact, say 30 to 35 kg. per square millimetre (66 lbs. to 77 lbs.), before the material of the plate begins to yield and flow aside, while the point of the projectile forces its way into the plate like a chisel. The iron thus under pressure moves, of course, in the line of least resistance, and thus there is formed on the front of the plate by the pushing up of the material very peculiarly characteristic curls and elevations, and at the same time a bulging occurs on the back of the plate. The pressure of the point in the canal that is forming keeps growing, without passing beyond the limit of tenacity of the projectile, and so without deforming it, until the point breaks through the plate, when the pressure quickly drops to zero, which it reaches when the point and ogival head of the projectile clear the plate. By the action of the projectile's head lateral motions are imparted to small masse, and so the canal is widened, and on the back of the plate there is a considerable puffing up of the plate without any actual loss of material. The form of perforation shown in Fig. 2 indicates little hardness in the plate, but great tenacity.

Homogeneous soft steel or unhardened nickel-steel behaves somewhat differently. In the first instant the same phenomena are observed as in the case of wrought iron, with curling elevations on the front of the plate. But since the tenacity of steel is less than that of wrought-iron, radial cracks and fissures will occur on the back of the plate, and instead of a projecting collar there we will find a rim of pyramidal-shaped teeth, some of which break off and are flung about, so that the back of the plate will present a broken surface more or less circular in shape surrounding the orifice made by the projectile.

The behavior of the best K.C. plates is radically different. Since the resistance to penetration is very much greater than is the case with unhardened plates, the projectile is arrested in its motion almost instantaneously, so that an enormous pressure occurs on the head of the projectile (not less than 100 kg. to 200 kg. per square millimeter) (220 lbs. to 440 lbs.), which the best material and the most careful hardening cannot withstand. Hence at the instant of impact the head of the

FIG. 6

projectile is deformed, and the broad, rounded surface that the front of the projectile now presents seeks to compress the material of the plate, since piercing is out of the question on account of the broader dimensions of the front due to the upsetting of the point. The result is that the front surface of the plate is pressed in, and, of course, the rear side bulges out.

During the process, which occupies an extremely short time, the cylindrical body of the projectile continues its forward motion, until, arrested by the deformed head of the plate, the low tenacity of the tempered material is overcome and the projectile breaks up. The head of the projectile, broken loose by the resistance it has met, adheres with great force to the plate, and is, so to speak, welded to it. The mushroom form which the head assumes is characteristic of this phase, the stem of the mushroom being bounded by the hollow interior of the projectile. In Fig. 5 the formation of this mushroom head is very noticeable. If the energy of the impact is small, the plate will be able to keep out the projectile without further injury, that is, by its elasticity it will take up the energy that remains after the shattering of the shot and the heating of the place of striking. The effect of the projectile ceases then with the process we have described, the plate completely shutting out the projectile.

If the energy of impact is relatively large there is a portion of it transferred to the plate sufficient to effect an opening or to cause perforation. The process that then takes place can be readily explained on the basis of the law that governs the action of imperfectly elastic bodies.

The head already deformed in the previous phase becomes now the vehicle for the transference of a portion of the striking energy, and presses like a punch on a surface of greater or less extent, pushing out from in front of it a cylindrical portion of the plate like a stopper. The shearing strength of the material of the plate is overcome at the surface of this stopper, without an actual piercing of the projectile into the material. As a final result the plate is either completely perforated, or if the stopper of metal punched out from the plate holds to the plate by a portion of its surface, the plate is said to be simply opened. In this way there arises on the back of the plate the characteristic form represented in Fig. 6.

In any case, whether the plate is perforated or not, the projectile breaks up into a great many very small pieces. This occurs to all projectiles, including those of the best quality, so that behind the plate, even after complete perforation, are to be found but fragments of the projectile and of the metal forced out from the plate.

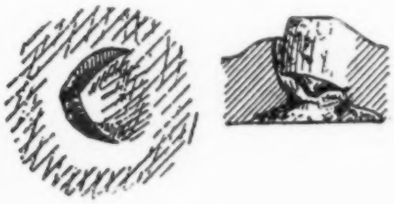


FIG. 7

This manner of penetration is as characteristic for hard plates as that previously described is for soft ones. When plate-thickness and caliber agree approximately, there is practically never any other phenomenon to be observed than that indicated. If this is not the case, that is, if the caliber of the projectile is considerably greater than the thickness of the plate, as for example, a 24 cm. (9.4 in.) projectile against a 160 mm. (6.3 in.) plate, the shock is so great that a large piece

of the plate simply breaks off. On the front of the plate is to be seen an irregular cracking, and on the rear a large concave surface. But even in this case the head of the projectile is deformed and welded with the plate, and the projectile is shattered into a thousand small fragments.

It is obvious, of course, that these phenomena are beyond our control. Aside from the fact that it would be extremely dangerous to observe the penetration of a plate in close proximity, the time occupied is so infinitesimally small that the preservation of a record of the separate phases

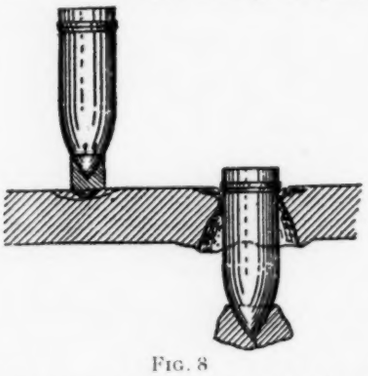


FIG. 8

of the process, as by photography, is out of the question. Hence all of these explanations are but hypotheses; but a certain probability is not to be denied them, for they are deduced from actual experiments, and new tests always confirm them. The explanation of the action of capped projectiles that follows possesses also but a hypothetical value, yet it fits so close to what has gone before that a preference may also be given to it, in view of the defects in the theories that I have before referred to.

We have seen that the action of the projectile against hard plates is unsatisfactory because the great pressure per square inch that is brought to bear on the point causes the breaking up of the projectile. A certain amount of flattening of the head from this point of view should be looked upon as advantageous, for the greater the surface that bears the pressure, the less pressure is there per unit of surface. Tests that have been made, however, show that on account of the increased difficulty of penetration a flat-headed projectile does not give better results than a pointed one. Hence the construction of capped projectiles has been resorted to, for this diminishes the pressures on the unit surface, while at the same time the advantage of a point in the penetration of the plate is not surrendered.

The superior action of the capped projectiles rests therefore on the fact that the point of the projectile is not deformed at the first instant of impact with the plate. Due to the presence of the cap, the pressure is not confined simply to the point, but is distributed uniformly over a fairly large cross-section. The unit pressure therefore does not exceed the limit above which the choice tempered material of the projectile would be impaired. As a consequence the point is not deformed at the first instant of impact, but pierces like a chisel into the hard layers. This work will be so much the easier for the projectile, since the "material cone" formed in the plate, due to the cap, will already have begun the destruction of the outside diamond-hard surface layer of the plate, which is not more than a few millimeters thick. At this stage the cap has already fulfilled its mission, and the projectile goes on its way through the plate alone and uninjured. The following process now occurs:—

The point having once entered the exterior hard layer forms a path for itself in this portion of the plate by its ever-widening head, forcing aside the particles in its front, their cohesion having been already disturbed by the formation of the "material cone." On the front of the plate there is a crumbling characteristic of hard metal. Where the hard metal layers pass into the softer ones this crumbling no longer occurs on account of the greater tenacity of the latter. The perforation now narrows to dimensions not much greater than the caliber of the projectile. It might be thought that the further progress of the projectile would resemble the perforation of soft homogeneous steel plates. This, however, is not the case, for the quantities of steel intended for hardening differ very materially from those of unhardened steel. The material that the projectile now meets is less tenacious than homogeneous unhardened steel, so that a cylindrical section of the plate in front of the projectile is forced out like a stopper. After penetration, therefore, the back of the plate presents the appearance of a plate hardened throughout. The stopper of metal forced out of the plate is usually broken up into several pieces, because the head of the projectile having passed through without injury, in normal penetration, this piece remains about the thickness of the caliber of the projectile. Hitherto no trace of the cap has been found. Probably it is driven radially on penetration, and broken up, so that its pieces mingle with the fragments of the plate.

The superiority of the action of the capped as compared with uncapped projectiles rests therefore, as stated, on the fact that the head of the projectile remains intact. With the ordinary projectile the velocity upon impact falls off so suddenly towards zero, that the pressure increases until it reaches a point where the cohesion of the metal of the projectile is overcome; with capped projectiles however, on account of the distribution of the pressure over a larger area, the pressure per unit of area does not reach this limit, and it still remains below this limit in further penetration, because the hardened exterior layer is weakened by the formation of the material cone. The pressure curve for capped projectiles against hard plates will therefore resemble that for pointed projectiles against soft places. At first, while the ogival head is entering the plate, the curve will slowly rise until the head has completely entered. When the stopper of metal breaks out of the plate, the curve will fall steeply, so that at this point it will show an angle. This curve represents the total pressure, for the pressure per unit of area decreases from the start, because with the increase of the total pressure the surface receiving it also increases.

On the other hand, the pressure curve for uncapped projectiles resembles that for a flat-headed projectile. The total pressure rises rapidly, and maintains itself at about a constant height so long as the shearing strength of the plate at the place of impact is not overcome; once the plate is punched it sinks rapidly. The pressure per unit of area on the head grows rapidly from the instant of impact until the head of such disappears. The

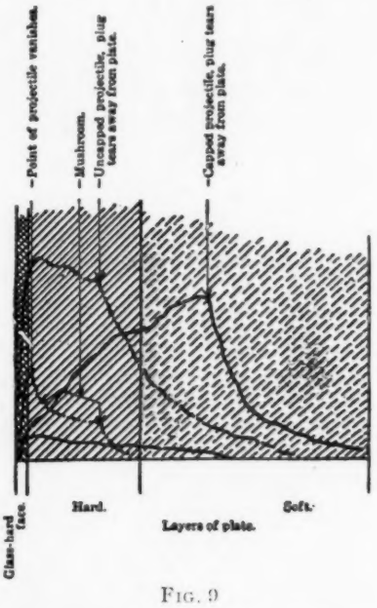


FIG. 9

area included between each curve, the axis of abscissæ, and the extreme of ordinates, must be equal in each case, since this area represents the work done.

It will be apparent from this discussion that the problem of the capped projectile, remarkable as the results appear at first sight, is yet capable of an explanation on a simple mechanical basis. The transfer of the pressure from the surface of impact, the front of the cap, to the working cross-section of the ogival head, takes place in a wave of motion at an enormously high velocity, practically instantaneously, and the pressure may be regarded as completely and uniformly taken up if the cap is firmly seated upon the projectile.. A good, solid attachment of the cap to the body of the projectile is there

fore the weightiest factor in the construction of the capped projectile. In order that the transfer of pressure may properly be accomplished, the cap must be seated in the closest contact with the projectile's head throughout its entire interior surface. If this condition is fulfilled it insures that the cap will not part from the projectile either in the bore or in the air; the first might lead to accidents, the second to wild shooting. Such a firm and absolutely reliable attachment is only to be secured by means of a metallic soldering. This method would also remove the defects due to any small room for play that might remain between the cap and the projectile after grinding. A solder suitable for this purpose must possess two qualities: (1) it must possess sufficient firmness, and (2) a low point of melting so that the tempering of the point will not be affected during the process of soldering. This requires that it should lie considerably below 200° C. Now these two qualities are opposite, since ready melting usually goes with small firmness. Thus there are difficulties in the way of obtaining a suitable alloy, so that the method of soldering is not in general use.

The method of soldering has the advantage that projectiles on hand can be easily fitted with a cap, and in manufacturing new shell no regard need be paid as to whether they will or will not be furnished with a cap. A great advantage of soldering in comparison with other means ordinarily employed to attach the cap, lies in the fact that by this process the head of the projectiles is not weakened, as it is when grooves or channels are turned in the head. Ridges in the vicinity of the head have the disadvantages that they are liable to cause a cracking upon tempering. When grooves are turned into the head of the finished projectile the exterior surface is injured, and it may happen that the hard outer layer already under tension may be broken by the strain from within. Not only may the head be cracked in this way,but the whole projectile may disrupt before it is ready to be used.

Another method of attaching the cap is to screw it on the head. Of course, this method applies only to the new projectile before hardening.

As regards the material out of which the cap is made, it appears on the whole, that there is more freedom of choice in this than would seem likely at first. The naval-technical committee employed in its experiments a number of different materials differing very widely in their physical properties, and yet no variation was observed in the results. Probably each firm and each State that conducts experiments with capped projectiles uses a different material from any other, with results more or less satisfactory. The chief requirement is a proper amount of elasticity of compression (the material must not be too soft), and a relatively large tenacity, so that the cap will not fly to pieces on impact with the plate.

Nor does it appear that the form of the cap has much effect on the results, since nearly every manufacturer chooses a different one. Some of the more common ones are represented in Fig. 10, but there are a great many forms besides these. It is essential that the front of the cap should present a broad surface, and that it should rest against a large cross-section of the head. The first creates a larger material cone in the plate, the latter diminishes the unit pressure on the head. In any case the best form is the one that produces an adequate effect with a minimum volume and weight. On ballistic grounds it is indifferent what form of head is adopted, for with great velocities this modifies the trajectory very little, which is not the case with low velocities. The greater the velocity the less important is the shape of the head. At the same time it is to be noted that the displacement of the center of gravity towards the point influences favorably the trajectory, increasing both accuracy and range. Many tests by the Krupp firm confirm this fact respecting capped projectiles.

Besides the advantage that the capped

FIG. 10

projectile possesses over ordinary uncapped shell, in that its penetrative power is increased about 20 per cent., there remains to be mentioned the following advantage of the new type, viz., that the shell goes through the plate whole or at the limit of its energy breaks into a few large fragments. This tends to increase the bursting effect very much. The bursting charge of the ordinary armor-piercing shell (and the same applies still more to the weakly constructed fused shell) can never be fully utilized because the shell is shattered on the hard exterior surface, so that the explosion occurs in front of the plate and thus outside of the protected area. At best only a few fragments arrive at back of the plate, and these make a dangerous conical space only in the prolongation of the trajectory. The whole territory at back of the place of impact is not rendered unsafe, as it should be upon the penetration and explosion of a shell. A satisfactory shell explosion can only occur when the shell arrives intact behind the plate. The use of high explosive preparations insures a mine effect with capped projectiles, even when the inner cavity is small, and a result is produced much greater than that of uncapped fused shell that have a much stronger bursting charge.

Unfortunately, the value of the cap is not the same for all velocities. A pronounced superiority of the capped projectile compared with ordinary shell is only to be secured with high striking velocities. With low velocities, even when the capped projectile has sufficient energy to penetrate the thinner plate, the effect of both types is about the same. Hence, at long ranges, the capped projectile is no more effective than ordinary shell. The limiting velocity is about 500 m. sec. (1,650 ft. sec.), and as this velocity with 12 cm. L/40 (4.7 in., 40 caliber) guns is attained at ranges of 2,000 m. and to 2,400 m. (2,200 to 2,625 yards) and with 15 cm. L/40 (6 in., 40 caliber) guns at about 2,800 m. (3,100 yards), and with modern 24 cm. (9.5 in.) guns at about 7,000 m. (7,650 yards), it will be seen that the utility of the capped projectile is at best limited to close fighting ranges. At these ranges the effect of the shell is so increased that the cap is of great advantage: beyond the limits indicated above the cap is of no advantage.

The Combustion of Small Coal.

A number of improvements have been made in Germany during the past year or so, in the construction of apparatus for the combustion of small coal of inferior grades, according to the London *Electrical Review*. A forced draft apparatus has recently been into use in Hamburg which consumes anthracite dust up to 4 millimetres in size. It works without a chimney shaft, so that deposition of ash in the flues does not occur. Lately a firm at Dresden designed a suction gas generator for employment with low-grade small coals. The hearth is built step-fashion, and is funnel-shaped; under the bars is a receptacle for water. The upper part of the generator is also fitted with a water jacket; and the liquid from this, as well as the water in the bottom, is caused to evaporate and enter the generator with the indrawn air. Practically, therefore, the generator yields a semi-water gas.

Strictly speaking, the draft-tube of a turbine water-wheel is that portion of the tube leading from the wheel itself into the tail-race; the name, however, is often erroneously applied to the vertical tube or penstock.

The voids in concrete will be larger if the broken stone is screened of its small sized fragments, and the proportions of sand should be increased correspondingly. Should the stone be the "run of crusher" the proportions may be determined by experiment to be those most economical of cement and sand.

Personal.

Will the person who signs himself "R. Henry" kindly communicate with the editor?

Prof. Henry F. Rugan, of Tulane University, has been advanced to the grade of associate professor of mechanic arts, and Dr. Joseph Ivey to the rank of associate professor of mathematics and astronomy.

The J. W. Cregar Agency, The Bourse, Philadelphia, has retired from business, and Mr. Cregar has accepted a position in charge of the miscellaneous department of the Niles-Bement-Pond Company, in Philadelphia.

E. L. Smith, who until the first of June was general foreman of the Vulcan Iron Works, Denver, Colo., resigned to become superintendent of shops of the John A. Traylor Machinery Company, manufacturers of mining and milling machinery, Denver, Colo.

H. Van Atta has retired as superintendent of the J. L. Mott Iron Works, New York. His temporary business address after July 1 will be care of the Ajax Decorating Company, One hundred and thirty-eighth street and Third avenue, New York City.

C. C. Abbott, who for the past six years has been in the mechanical engineering department of the Stanley G. I. Electric Manufacturing Company, Pittsfield, Mass., has resigned and accepted a position as general manager with the Triumph Voting Machine Company.

Fred Perkins, superintendent of the Perkins Machine Company, Warren, Mass., builders of punches, shears, bending rolls and power presses, leaves, Aug. 2, for a business tour through England and the European countries. A. P. Lee, one of their engineers, will accompany him. The object will be to familiarize the trade and their agents with Perkins power presses.

Newell Sanders, prominent in American Society of Mechanical Engineers affairs, and head of the local committee during the recent meeting of that society in Chattanooga, has been chosen chairman of the Republican Executive Committee of the State of Tennessee, and as such will have charge of the coming campaign of that party for the election of the Governor. Local papers are saying that it will at least be a cleanly conducted campaign, and those who know Mr. Sanders can easily believe it.

Obituary.

Earl A. Smith, president of the American Mills Company, the Smith & Griggs Manufacturing Company, and the Waterbury Buckle Company, died at his home in Waterbury, Conn., July 22, aged 76.

James Brady, former manager of the Brady Manufacturing Company, of Brooklyn, N. Y., died, July 24, in his summer home Lake Sunapee, N. H. He was born in Canada 69 years ago, and during the Civil War was an inspector of ordnance at the Springfield armory. He retired from business eight years ago, but had since been acting as consulting engineer to manufacturers. Mr. Brady, who started his active life as a tinsmith, developed great ingenuity, and did a great deal of experimental work for inventors. Many cash registers, typewriters and other machines of that class were developed in his shops, and he sometimes undertook the manufacture of machines. His somewhat irregular method of entering the business, combined with his great natural ingenuity, led him to undertake to do things in ways that would not have been thought of by a regularly trained man, and many of these ways were successful. He has been an occasional contributor to our columns, has been a member of the American Society of Mechanical Engineers since 1881, and was for a long time one of the best known mechanics in the vicinity of New York.

Business Items.

The Crocker-Wheeler Company, Ampere, N. J., made six recent sales of electric generators in as many different industrial lines, including a textile mill, coal company, college, zinc company, powder company and a general manufacturer.

E. W. T. Gray, who has for years been manager of the New York sales office of the Westinghouse Electric and Manufacturing Company, resigned recently to take up commercial work in another field. W. C. Webster succeeds Mr. Gray as manager of the New York sales office.

The London branch office of the Buffalo Forge Company and Buffalo Steam Pump Company has been changed from 39 Victoria street, East, to Caxton House, Westminster. This change has been made necessary by the constant and rapid growth of the company's business in Great Britain. The new offices afford a great deal of extra space and are more conveniently located.

Manufacturers

Bowler Bros., Ltd., Worcester, Mass., will erect a cold storage building.

The Monarch Motor Car Company, Chicago, Ill., has secured a factory building, which will be improved and enlarged.

The Springfield (Mass.) Facing Company, will erect a new plant at Williamansett, to replace the one destroyed by fire a short time ago.

The United States Reduction and Refining Company, of Colorado Springs, Colo., and elsewhere, is planning the erection of a new mill at Florence, Colo.

The Foehl Tool Company, Brooklyn, N. Y., which makes tools for jewelers and doctors, will move to Perth Amboy, N. J., where a new plant will be erected.

The Abbe Engineering Company, 220 Broadway, New York, will erect a large plant in Bayonne, N. J., for the manufacture of its pulverizing machinery.

The American Cotton Picker Company has been reorganized at Pittsburg, Penn., as the Pittsburg Cotton Picker Company, and the capital increased to $5,000,000. A new plant, at a cost of over $1,000,000, will be erected.

The Baldwin Locomotive Works, Philadelphia, Penn., will erect a plant at Eddystone, Penn., for the manufacture of iron castings for its own use. The plant will consist of two foundries, two blacksmith shops and a power house.

It is announced that a new million dollar yarn mill will be erected at Pawtucket, R. I., in the near future. Robert Burgess, formerly treasurer of the Slater Cotton Company, Pawtucket, will be the chief figure in the new enterprise.

It is announced that the Wheeler & Wilson Manufacturing Company, of Bridgeport, Conn., which was recently absorbed by the Singer Manufacturing Company, of New Jersey, is maturing plans by which its sewing machine output will be doubled within two years.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Agents to sell all kinds of counting machines. R. A. Hart, Batte Creek, Mich.

Wire and sheet metal working machinery and tools. Emmons Collins, Chicago, Ill.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Good tool or machine specialty wanted. Give full particulars. Automatic, 660, AM. M.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special machinery to order; inventions developed. Geo. M. Mayer, M. E., 1131 Monadnock Block, Chicago, Ill.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—One Brown & Sharpe, No. 2, wire feed hand-screw machine. Geo. W. Dover Co., 80 Clifford street, Providence, R. I.

Special machinery to order. Catalog of small engines and boilers and engine castings, 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

Second-hand grinding machine, size 10x24 inches, suitable for plain outside horizontal grinding. The Dayton Pneumatic Tool Co., Dayton, O.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

We have a modern machine-shop equipment and are prepared to design and build to order high-grade special machinery and tools. Cummings Machine Co., 182 William st., New York.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Wanted—A second-hand bending roll, approximately 16 to 18 feet long, for bending plates up to ¼ inch in thickness; give full particulars and lowest price. Address Box 855, AMERICAN MACHINIST.

The advertiser wishes to make a time contract with a first-class modern machine shop for the manufacture of a high-class special machine tool, weighing from one to 10 tons. Address Box 853, AMERICAN MACHINIST.

Well known and old-established firm in Birmingham, England, doing business with all the large engineering works, is anxious to take up the sole agency for some specialty worth pushing. Highest references given. Box 780, AMERICAN MACHINIST.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Wanted—Agents in every State to handle exclusive territory on the Cone Gas Generator, which generates coal gas for stationary engines from 25 h.p. up, reducing the cost to 1/5 that of steam power; agents must be conversant with machinery business and devote entire time to the work. Cone Gas Machine Company, 1036 Majestic Bldg., Detroit, Mich.

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Excellent machine-shop building, with power, in Philadelphia; 60x90 feet, three stories, solid ground floor. Box 545, AM. M.

For Sale—Going machine shop, situated in northern Ohio; natural gas; will bear strict investigation; good reason for selling. Address Box 525, Tiffin, Ohio.

For Sale—Black glass test bars, 5/16x1½x7 inches long, $3.50; knife-edge squares and straight edges; all tools guaranteed. "Scotty," Box 861, AMERICAN MACHINIST.

For Sale—One 50-h.p. gasolene engine, used only a few months and good as new; also one 25 h.p. Address Detroit Engineering Works, Chene and Guoin streeets, Detroit, Mich.

Patent 649,447—Feed devices for screw-cutting lathes; will cut all standard and fractional threads by moving one lever; no lead screw used. Address for particulars, John Grime, 70 Seymour avenue, S.E., Minneapolis, Minn.

One punch of the cam-and-lever type, belt driven gag block engaged and hand withdrawn. The reach of this punch is 24 inches from back of throat to center of punch; capacity, 1-inch hole in ¾-inch plate; in first-class condition. Also a lot of shop supplies, list of which will be furnished on application. Box 865, AMERICAN MACHINIST.

For Sale—3-motor electric crane, Northern Engineering Co., 32 feet 3-inch span; first-class condition, with rails and run-way shed 192 feet long and wiring complete. Capacity, five tons; will handle eight tons. Price, traveler, $1500; run-way and wiring, $500; wooden shed, $300. Can be seen operating. Edwin Shuttleworth Co., 105th St. and East River, New York City.

A 500-h.p. cross-compound Corliss engine, built by C. & G. Cooper Co., of Mount Vernon, O. Also three 150-h.p. tubular boilers, built by Bass Foundry and Machine Co., of Fort Wayne, Ind., with fronts, stacks, brick stays and fittings complete. Also two Ingersoll-Sergeant air compressors of the piston-intake type, 16¼x42 inches, and a capacity of three million cubic feet in 24 hours. Also two Ingersoll-Sergeant air compressors 12¼x42 inches. All the above are in first-class condition, practically as good as new. Cost to install $35,000. Will be sold at a bargain on quick sale. Located in Indiana. Address New York & Western Consolidated Oil Co., 41 Wall St., New York.

Business Opportunities.

An opportunity for a live man with capital to invest in a well-equipped manufacturing plant; have all patterns, tools, etc., for manufacture of gasolene engines up to 40 h.p.; engines are of a well-known make; only those with ability to handle either the business or manufacturing end need answer. Address D. R., Box 868, AMERICAN MACHINIST.

A company manufacturing a machine which has been sold to, and accepted by, the U. S. Government, and which has no effective competition to meet in this and other important markets, desires to increase its capital by interesting someone who believes in what is known as industrial betterment. Answers are requested from principals only. Address "Betterment," care American Institute of Social Service, 287 Fourth avenue, New York.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

MASSACHUSETTS.

Expert planer hand wants position in charge; experienced; would operate in small shop; American, 35, with 10 years' study. Box 864, AMERICAN MACHINIST.

NEW HAMPSHIRE.

Foundry foreman, experienced in marine and stationary engines and jobbing, iron and brass, mixing and melting; ten years foreman. Address Box 824, AMER. MACHINIST.

NEW JERSEY.

Draftsman and designer, with first-class experience in gas and gasolene engines, desires change with good prospects, any location. Address Box 869, AMERICAN MACHINIST.

NEW YORK.

Salesman—Practical machinist and draftsman wishes position as salesman for machine tools or similar line. Box 867, AMER. MACH.

Automatic screw-machine foreman operator wants position; ten years' experience all machines. Address "Automatic," Box 870, AMERICAN MACHINIST.

General foreman, successful in producing first-class work at satisfactory cost, varied experience in high-grade machinery, master machinist, desires change. Box 854, AM. M.

Mechanical draftsman, long experience in manufacturing plant, has been purchasing agent and salesman, wants position in New York City in any of above capacities. Box 852, AMERICAN MACHINIST.

Practical mechanic, American, 33, technical education, experience designing and building small, accurate interchangeable work, printing presses, steam engines, etc., wishes engineering position, preferably outside; salary to start, $2500. Box 866, AMERICAN MACHINIST.

PENNSYLVANIA.

General erecting engineer is open for engagement; expert erecter, operator and tester of automatic and Corliss engines and steam engineering. For information, etc., address Box 860, AMERICAN MACHINIST.

TEXAS.

Technical graduate desires position in mechanical line, with chance of advancement; three years' machine-shop experience and one in college shop. Box 850, AMER. MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Wanted—Tool designers for small interchangeable work; also several competent toolmakers experienced on fixtures, dies and gages. Address, with full particulars as to experience and wages required, Ross Rifle Company, Quebec.

CONNECTICUT.

Wanted—Several competent all-around jobbing machinists. The Eastern Machinery Co., New Haven, Conn.

Machinists wanted—Several first-class, all-around machinists for general repair work. Apply to the Yale & Towne Mfg. Co., Stamford, Conn.

Tool and diemakers wanted—Several first-class toolmakers on jig and fixture work; steady employment. Also a number of diemakers for new and general repair work. Apply to Yale & Towne Mfg. Co., Stamford, Connecticut.

ILLINOIS.

Wanted — A thorough up-to-date superintendent to take charge of shop employing about 250 men and building a line of pumps and hydraulic machinery; plant located in middle West. Address Box 801, AMER. MACH.

Wanted, draftsmen — We want capable draftsmen of either electrical, mechanical or general experience. If you would like to change your position or its location, write and tell us about the character and extent of your work. Address, giving full particulars, to Western Electric Company, Dept. N. 29, Chicago.

Wanted—An experienced factory superintendent for the manufacture of a variety of metal specialties; man must be of good character, reliable, painstaking, mentally alert, and a thorough master of detail. The factory is new and well equipped. Salary $2000 per year, but superintendent must make cash investment of $3000 and contract for three years. Box 871, AMERICAN MACHINIST.

IOWA.

Wanted—Machine-shop foreman; must be first class in the construction of hoisting engines and mining machinery. Address Ottumwa Iron Works, Ottumwa, Iowa.

MASSACHUSETTS.

Wanted — Draftsman, with knowledge of shop methods, for jig and fixture designer. Deane Steam Pump Co., Holyoke, Mass.

Skilled man accustomed to spiral gear cutting; must have ability and good references. Boston Gear Works, Norfolk Downs, Mass.

Wanted — First-class draftsmen and toolmakers on light interchangeable work; state age, experience, salary and references. Box 834, AMERICAN MACHINIST.

Wanted in New England, competent draftsman and designer for concrete construction; must be posted on latest methods; state age, experience and salary expected. Address Box 829, AMERICAN MACHINIST.

Wanted—An experienced operator on Gould & Eberhardt gear cutters on heavy work; a man who knows how, and can tell how, to cut gears; man with theoretical and practical knowledge preferred. Box 856, AM. MACH.

Wanted—Corresponding assistant to manager of factory; must be practical and experienced, well posted upon systematic and scientific methods of estimating on varied mechanical work; gear specialist preferred; also one thoroughly experienced shop manager. "Gears," Box 831, AMER. MACHINIST.

MICHIGAN.

Machinists wanted—A first-class layer-out and several first-class floor hands on electric traveling-crane work. Northern Engineering Works, Detroit, Mich.

Wanted—General foreman by firm employing 40 men, manufacturing gasolene engines; must have first-class mechanical and executive ability; no other need apply; state experience, wages and references first letter. Box 862, AMERICAN MACHINIST.

MINNESOTA.

Wanted—First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

MISSOURI.

Wanted—Superintendent for screw-machine products. Box 849, AMERICAN MACHINIST.

Competent night foreman over about 20 machine tools, gas-engine work; must be familiar with reduction of costs, have had experience in the handling of men, and be between the ages of 25 and 40; chance for promotion if ability is shown; present salary $3.50 per day. Witte Iron Works Co., Kansas City, Mo.

NEW JERSEY.

Wanted—Mechanical electrical draftsmen; only first-class men need apply. Box 508, AMERICAN MACHINIST.

Wanted—Several competent machinists to work in shop connected with factory in New Jersey. Frank Brookfield, 220 Broadway, New York City.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Draftsmen wanted by metallurgical plant between New York and Philadelphia; steel, copper and lead-plant experience desirable, but not essential; applicants must state age, nature of experience and references, and salary to start. Box 844, AMER. MACHINIST.

NEW YORK.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted—Two operators for Ingersoll milling machines and one for 6-foot boring mill; write, giving experience and references. Otis Elevator Company, Yonkers, N. Y.

Draftsmen on jigs, fixtures and tools wanted; experienced men only. Mergenthaler Linotype Co., 20-42 Ryerson street, Brooklyn, N. Y.

Experienced machinist capable of taking charge as foreman of shop employing 40 to 50 hands. Must be capable of handling men, and a good executive. State experience in detail and salary wanted. Box 797, AM. MACH.

Wanted—At Kingston, N. Y., machine foreman for shop employing about 40 men; must be thoroughly familiar with up-to-date methods; good opportunity for advancement; salary, $3.50. Box 838, AMERICAN MACHINIST.

Machinery salesman wanted for New York City. Must have a good knowledge of mechanics and be able to estimate. State age, salary and experience; otherwise, application

will not be considered. Address M. S., P. O. Box 844, New York.

Foreman wanted—To take charge of a job of about twenty hand-screw machines; steady job assured to a person combining both the mechanical and executive skill for producing high-grade output in steel; location New York City. Address Box 863, AMERICN MACHINIST.

Wanted—Several engineers and draftsmen who have had experience in the design, construction and operation of refrigerating and ice-making machines and plants; must be thoroughly up-to-date and well informed on best modern practice in this line of machinery. Address, stating age, experience and salary expected, Box 858, AMERICAN MACHINIST.

Wanted, in the factory office of a machinery manufacturer in Brooklyn, an intelligent, conscientious young man about 18 or 20 years of age; must have a fair education and be good at figures; a knowledge of factory costs would be an advantage; the right party will receive an excellent opportunity; state particulars and salary expected. J. F. S., Box 851, AMERICAN MACHINIST.

OHIO.

Wanted—High-grade machinists for engine work. S. M. Jones Company, Toledo, Ohio.

Wanted—By the Bickford Drill and Tool Company, Cincinnati, O., experienced toolmakers, vise and scraper hands.

Mechanical draftsmen, two technical graduates, experienced transmission-machinery men; good permanent positions for capable men. Box 34, Cleveland, O.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity fro machinists. The American Tool Works Co., Cincinnati.

Chief mechanical draftsman, technical graduate, experienced transmission machinery; good permanent prospects with growing concern in Ohio; state definite qualifications and salary expected. Box 802, AMER. MACH.

PENNSYLVANIA.

Wanted—First-class machinists and toolmakers; good wages to right parties; no labor troubles. Box 857, AMERICAN MACHINIST.

Wanted — Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A first-class diemaker, one who has had experience in sheet-metal work, understanding the work thoroughly, also able to manage other die-workers; give wages expected, also references; first-class position for right party. Box 847, AMERICAN MACHINIST.

Wanted — By automobile company manufacturing high-class cars, a foreman to take charge of chassis and transmission assembling departments; must have good executive ability, quick at devising rapid and accurate methods of producing results; one now holding such a position preferred, and who can produce the best of references from former employer; state age, where now employed, and in what capacity, also salary expected. All applications will be treated strictly confidential. Address Box 826, AMERICAN MACH.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

Draftsman and designer in a shop employing about 50 hands and manufacturing light machine tools, hydraulic and pneumatic appliances. We want a capable man, self-reliant, accustomed and able to take an idea and reduce it to practical form, with the brains and disposition to stick to a problem until it is solved. If you do not have these qualifications, don't write. A pleasant position and chance of advancement to the right party. Location, Philadelphia. All communications will be treated confidentially. Give full particulars as to past experience, age, present employment, and state salary expected. Box 859, AMERICAN MACHINIST.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Pierce Mfg. Co., Woonsocket, R. I.

VIRGINIA.

Wanted, at once, diesinkers; steady work at 50 cents per hour; also several good trimmer makers. Address P. O. Box 686, Richmond, Va.

WISCONSIN.

Allis-Chalmers Company, Milwaukee, Wis., wants immediately six draftsmen to design machine toools.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., of Milwaukee, need more patternmakers, machinists and moulders.

Wanted — Draftsmen with experience on Corliss engine work; permanent positions for right men. Appy to Wisconsin Engine Company, Corliss, Wis.

Wanted—A few first-class machinists, toolmakers and patternmakers; shop one of the best in the country and equipped throughout with the highest grade of tools; city one of the best in the country; educational facilities of the best; pure water, etc.; only steady, reliable men looking for permanent positions need apply. Address Box 848, AMER. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis,. are constantly increasing their works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

Foreman—Mechanic for steady employment to act as foreman of an automobile repair department at our factory; ability to rapidly comprehend and to conscientiously carry out instructions more desirable than special knowledge of automobiles; wages depending on ability, but we would prefer one that is worth $30 weekly to one of less earning capacity. Box 825, AMERICAN MACHINIST.

WEST OF MISSISSIPPI.

Wanted—Two blacksmiths and four machine hands on general machine work; steady employment; wages $4 per day of 8 hours; open shop; applicants must state experience fully, as only first-class mechanics will be considered. Box 830, AMERICAN MACHINIST.

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Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Cochrane-Bly Co., Rochester, N.Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

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Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Dodge & Day, Philadelphia, Pa.

Ball Bearings

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Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Eng. Works, Chas. F., Chicago, Ill.
Matthews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Belt Dressing

Dixon Crucible Co., Jos., Jersey City, N. J.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Montgomery & Co., New York.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Bending Machinery, Plate

Bertram & Sons Co., Ltd, John, Dundas, Ontario, Canada.
Niagara Machine & Tool Wks., Buffalo, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Wm., Phila., Pa.

Bending Machinery, Plate—*Continued.*

Toledo Machine & Tool Co., Toledo, O.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machines, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machines, Power

Bertram & Sons Co., Ltd, John, Dundas, Ontario, Canada.
Bertsch & Co., Cambridge City, Ind.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers & Co., Wm., Phila., Pa.
Swaine Co., Fred J., St. Louis, Mo.

Bending Tools, Hand

Esten & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Bicycle Parts
Standard Welding Co., Cleveland, Ohio.

Blanks, Nut and Screw
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains
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Blowers
Am. Blower Co., Detroit, Mich.
Am. Gas Furnace Co., New York.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.
General Electric Co., New York
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Bros. Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

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Buckeye Engine Co., Salem, O.
General Electric Co., New York.

Boilers
Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery
Acme Machry. Co., Cleveland, O.
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Davis Machine Co., W. P., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote, Burt & Co., Cleveland, O.
Harrington & Son Co., Edwin, Philadelphia, Pa.
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Lang Co., G. R., Meadville, Pa.
National Machry. Co., Tiffin, O.
Northern Elec. Mfg. Co., Madison, Wis.
Niles-Bement-Pond Co., New York.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Bolt and Nut Machinery
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Wiley & Russell Mfg. Co, Greenfield, Mass.

Bolts, Coupling
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bolts and Nuts
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Mechanical
American School of Correspondence, Chicago, Ill.
Audel & Co., Theo., New York.
Henley Pub. Co., Norman W., New York.
Hill Pub. Co., New York.
Sames, C. M., Jersey City, N. J.
Wiley & Sons, Jno., New York.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
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Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley-G. I. Elec. Mfg. Co., Pittsfield, Mass
Westinghouse Elecric & Mfg. Co., Pittsburg, Pa.

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Lucas Mach. Tool Co., Cleveland, Ohio.
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Pawling & Harnischfeger, Milwaukee, Wis.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

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Armstrong Bros. Tool Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brazing Plates
Phillips-Laffitte Co., Phila., Pa.

Broaching Machines
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Bulldozers
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National Machry. Co., Tiffin, O.
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Toledo Machine & Tool Co., Toledo, O.

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Hammacher, Schlemmer & Co., New York.
Montgomery & Co., New York.

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Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Mass. Tool Co., Greenfield, Mass.
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Slocomb Co., J. T., Providence, R. I.
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Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fuchs & Lang Mfg. Co., New York.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
U. S. Foundry & Sales Co., South Norwalk, Conn.

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Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
National Machine Co., Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks., Boston, Mass.
Cullman Wheel Co., Chicago Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Engr. Co., Phila., Pa.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., The E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.

Chucks, Drill—*Continued.*
Montgomery & Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Oneida Natl. Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co, Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., The E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Scott & Sons Co., Medford, Mass.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Double Friction Coil Clutch Co., Chicago, Ill.
Eastern Machry. Co., New Haven, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Engineering Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Reeves Pulley Co., Columbus, Ind.
Wood's Sons Co., T. B., Chambersburg, Pa.

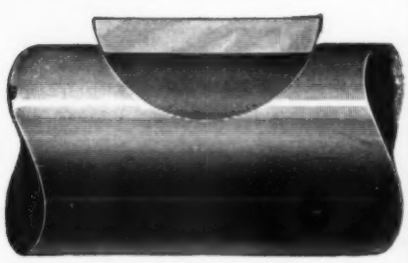
Coal Handling Machinery
Link-Belt Engineering Co., Philadelphia, Pa.

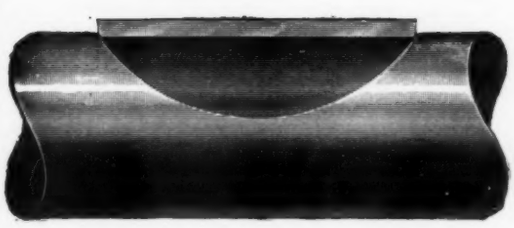
Coils
Standard Welding Co., Cleveland, Ohio.

Compound, Pipe Joint
Dixon Crucible Co., Jos., Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Mietz, August, New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

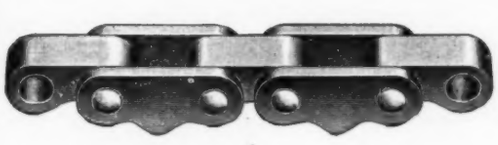




The "WOODRUFF" Patent System of Keying

and

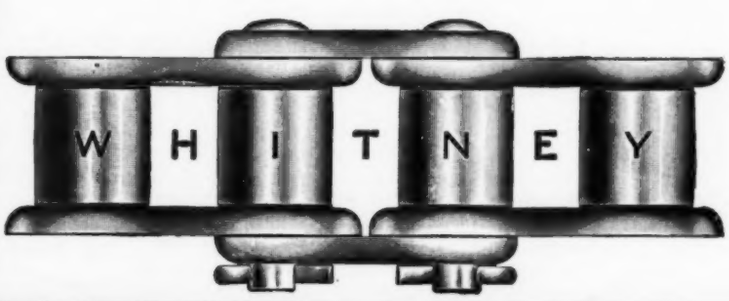
"WHITNEY" CHAINS



have been adopted by most of the leading manufacturers of

AUTOMOBILES, MACHINERY,

etc.



THE

WHITNEY MFG. CO.,

Hartford, Conn., U.S.A.

Condensers
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel - Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Boston, Mass.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, Ohio.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Correspondence Schools
See Schools, Correspondence.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters, Machinery
Durbrow & Hearne Mfg. Co., New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Cresson Co., Geo V., Phila., Pa.
Gisholt Mach. Co., Madison, Wis.
Reeves Pulley Co., Columbus, Ind.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels
Franklin Mfg. Co., Syracuse, N.Y.

Coupler, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cresson Co., Geo. V., Phila., Pa.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Engineering Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., N. Y.
Sellers & Co., Wm., Phila., Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes
Alliance Machine Co., Alliance, Ohio.
Brown Hoisting Mach. Co., New York.

Cranes—*Continued.*
Byram & Co., Inc., Detroit, Mich.
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, Ohio.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Phila., Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Ingersoll-Rand Co., New York.
Link-Belt Engineering Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.

Cut Meters
Warner Instrument Co., Beloit, Wis.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burr & Sons, John T., Brooklyn, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Cyclometers
Veeder Mfg. Co., Hartford, Conn.

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Gem Mfg. Co., Newark, N. J.

Dies, Drop Forging
National Tool & Stamping Co., Philadelphia, Pa.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Globe Machine & Stamping Co., Cleveland, O.
Kent & Co., Edwin R., Chicago, Ill.
Marchant, Geo. F., Chicago, Ill.
Niagara Machine & Tool Works, Buffalo, N. Y.
Swaine Co., Fred J., St. Louis, Mo.
Toledo Machine & Tool Co., Toledo, O.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.
Scott & Sons Co., Medford, Mass.

Drawing Boards and Tables
Obermayer Co., S., Cincinnati, O.
Queen & Co., Phila., Pa.

Drawing Materials
Queen & Co., Phila., Pa.
Soltmann, E. G., New York.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Dwight Slate Machine Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros Co., Worcester, Mass.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote, Burt & Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.

Drilling Machines, Multiple Spindle—*Continued.*
Dwight Slate Machine Co., Hartford, Conn.
Fenn-Sadler Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Drilling Machines, Turret
National Separator & Machine Co., Concord, N. H.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Dwight Slate Machine Co., Hartford, Conn.
Fairbanks Co., New York.
Fenn-Sadler Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cincinnati, O.
Foote, Burt & Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Knecht Bros. Co., Cincinnati ,O.
Marshall & Huschart Machy. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.

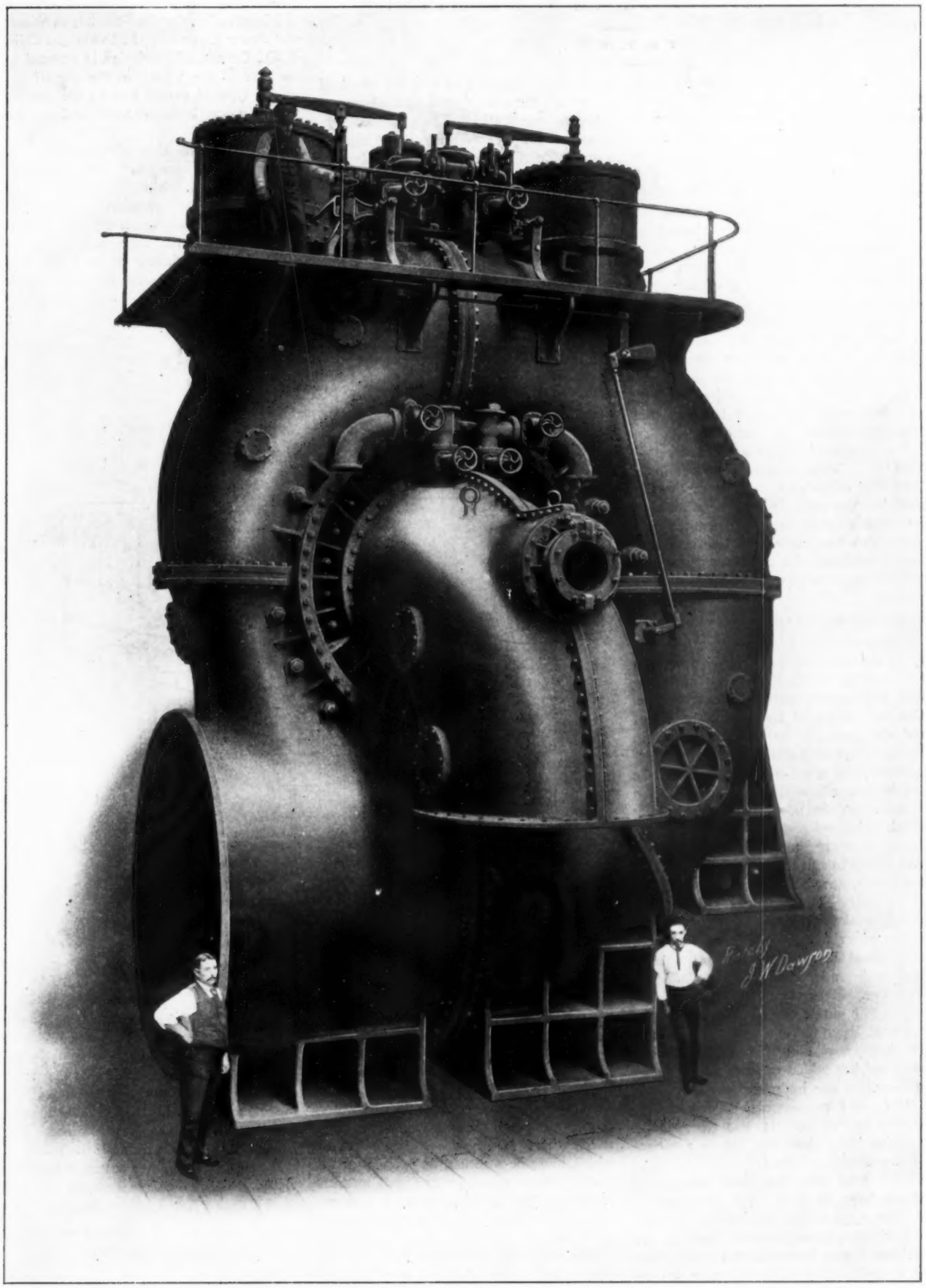


FIG. 1. A 10,500 HORSE-POWER TURBINE WHEEL.

A 10,500 Horse-Power Turbine with Volute Casing.

BY W. M. WHITE.

Turbine wheel construction in this country is entering upon an entirely new phase. The typical American turbine is an article of manufacture made from a set of patterns of definite sizes and listed for sale like high-speed engines. The design of these wheels, while involving theoretical analysis, has been largely the outgrowth of experiments conducted at the Holyoke testing flume, the wheels being tested and modified in accordance with the results and new sizes being designed on the lines of those previously built and then re-tested. The purchaser of these wheels ordinarily selects one from the list which will give the required power and connects it to the machinery to be driven by gearing which will change its speed under the given head to that required for the driven machinery.

The results of this process of development have been remarkable. Not only have the efficiencies been exceptionally high, but the reduction of the wheels to the manufacturing basis has resulted in a cost which has made the American turbine a machine of a combined cheapness and efficiency which is unmatched elsewhere.

NEW CONDITIONS IN THE TURBINE INDUSTRY.

New conditions are, however, now entering the development of water powers in this country to which this system of design and construction is not applicable. The desirability of connecting the wheel and the generator to the same shaft in electric generating stations makes it necessary that the speed of the wheel shall be pre-determined, while the speed of a stock design of wheel is exactly the thing which is beyond control, and it hence becomes necessary to design wheels for such plants to suit the conditions, in which the power, speed and efficiency are fixed in advance. These new conditions obviously make it impossible to make use of the experimental development method, each wheel being designed for its location and under a guarantee of performance. Moreover, the power now required in single units is far beyond the reach of listed wheels and the necessity for better governing than has heretofore prevailed has added another to the many problems of the hydraulic engineer.

The first important case of this kind to be met in this country was the original Niagara Falls plant and others are constantly coming to the front.

It is true that the older designs of wheels have, in some cases, been applied to direct-connected generating stations, but this is only occasionally feasible. By accident it may happen that a stock wheel or a modification of it will give the required speed and power under the given head and in other cases the generator may be specially designed to suit the speed of the wheel, but such a method is obviously of limited application. The great development of the Pelton and other impulse wheels for this class of work is largely due to their flexibility of design as regards speed. The peripheral speed of the buckets being fixed by the head, the required rotative speed can be obtained by suitable selection of the diameter, and, within wide ranges of power and head, the adaptation of these wheels to the conditions may be so made as to leave nothing to be desired.

An Example of the New Conditions.

In the great development of water powers through the utilization of electricity there are, however, many cases which must be attacked as original problems in their every feature, and in such cases a special design of wheel is a necessity. This article relates to such a wheel which was required to develop 10,500 horsepower at a speed of 180 revolutions per minute and under a head of 135 feet with a guaranteed efficiency of 78 per cent., and which was recently designed, built and installed by the I. P. Morris Company, of Philadelphia, for the Shawinigan Water and Power Company, of Shawinigan Falls, P. Q., Canada. The design is unusual in the size of the wheel, in the use of the volute type of casing and in the control of the gates both by hand and by the governor.

Fig. 1, from a shop photograph, gives an excellent idea of the magnitude of the wheel, while Fig. 2 shows its method of erection in relation to the power-house floor. The general design was the outgrowth of the desire of the engineers to have the supply pipe below and the generator above the floor, while the volute casing is the result of my conviction that it would give a better efficiency than any other type, because of the uniform velocity of the water as it passes around the distributors into the vanes, by which shocks are avoided and the full available head utilized. The European practice is to make the volute of such size that the water enters at high velocity, which of course reduces the size of the casing for a given output.

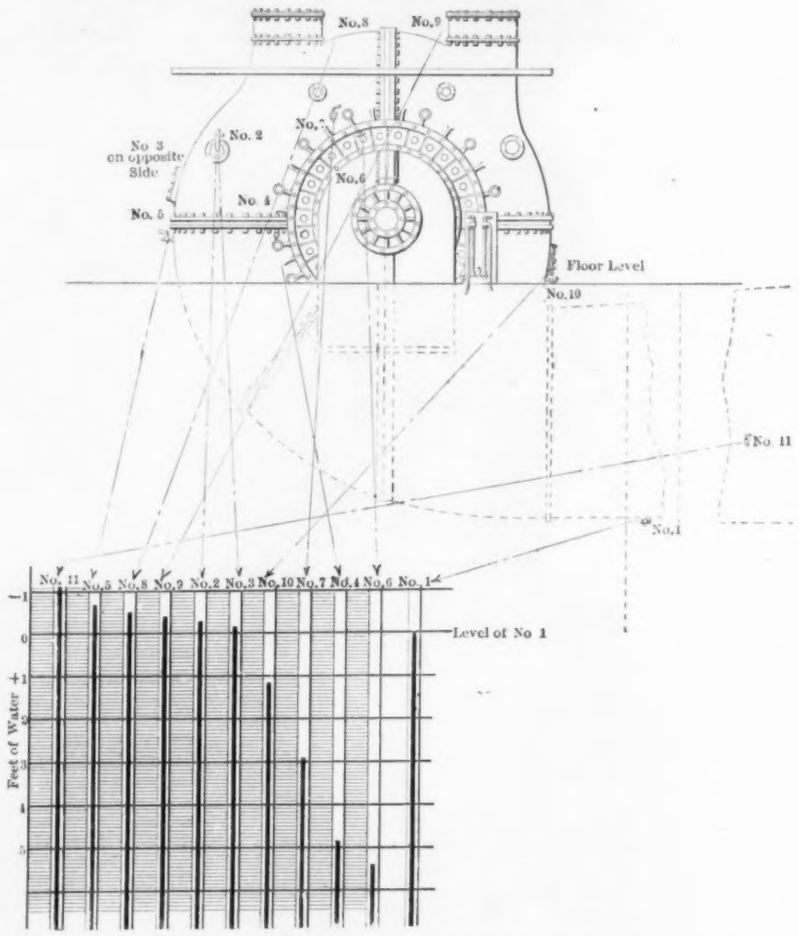


FIG. 2. TEST-PRESSURE CONNECTIONS AND READINGS.

MEANS ADOPTED TO SECURE HIGH EFFICIENCY AND THE RESULTS.

Believing that the prevailing velocities of 16, 18 and 20 feet per second at the entrance to the wheel were entirely too high,

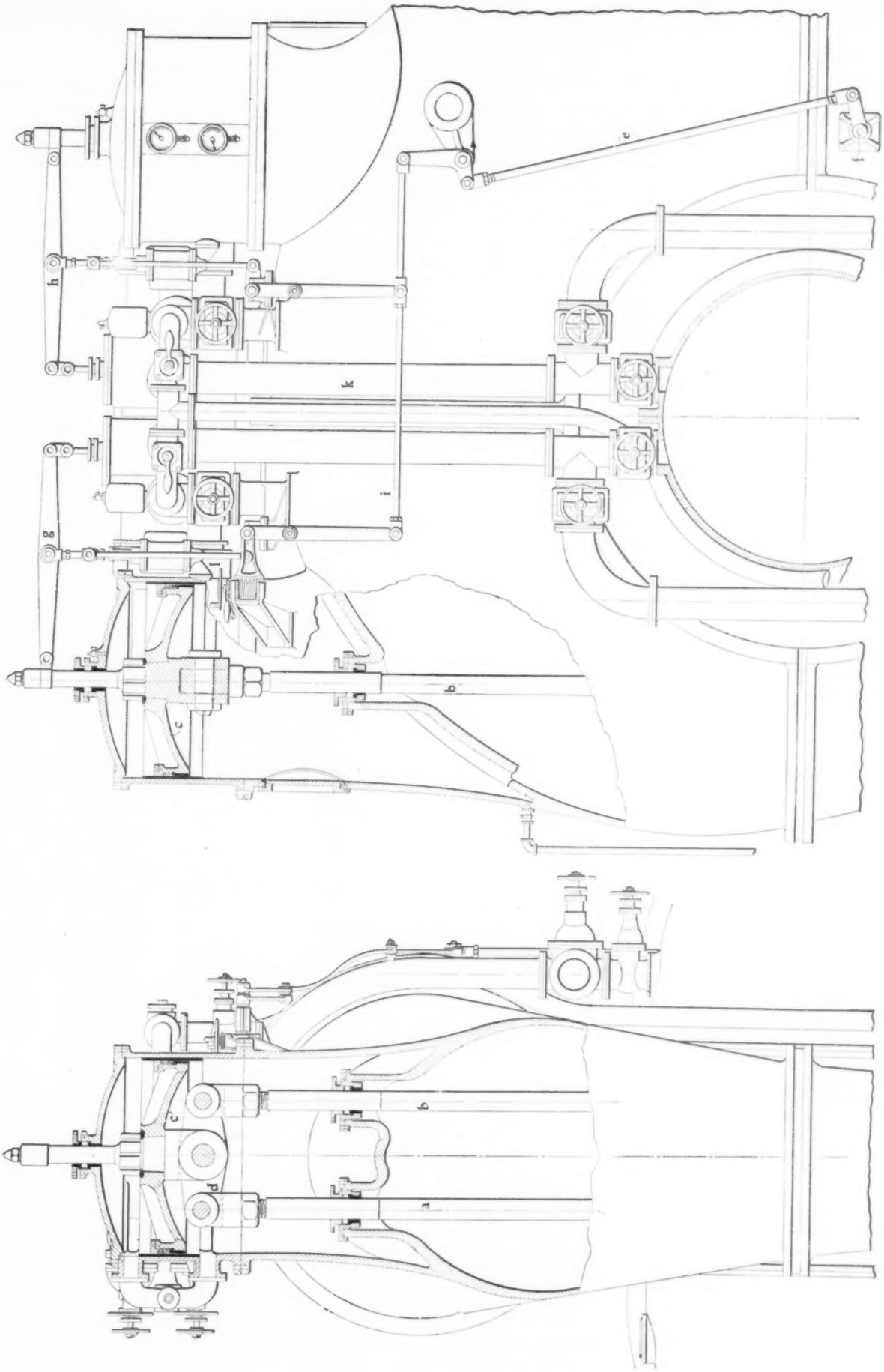


FIG. 3. HYDRAULIC GATE CONTROL.

leading to a loss of head due to the centrifugal force of the water passing around the casing, the velocity was reduced to 8.95 feet, which, of course, added largely to the size and cost of the casing; but the specifications being worded to provide a bonus for each per cent. by which the efficiency exceeded 78 when working at 9000 horse-power—the full load of the generator—it was believed that the increased cost would be recovered in the bonus, and, moreover, the company desired to produce a wheel which would reflect credit on it as builders of high-class turbine machinery. The outcome was entirely satisfactory, the efficiencies obtained under a test at which both builders and purchasers were represented by experts being as follows:

Load. H. P.	Efficiency Per cent.
11,270 or 7.3 per cent. overload	84.7
10,500 or contract. load	86.25
9,735 or 92.7 per cent. load	87.3
9,000 or 85.7 per cent. load	86 5
7,500 or 71.4 per cent. load	84.5
6,000 or 57.1 per cent. load	83.
3,000 or 28.5 per cent. load	73.5

The effect of the centrifugal force of the water in the casing is shown graphically in Fig. 2, which gives the results of pressure-gage readings in various parts of the casing referred to the pressure at the entrance to the casing as zero. When these observations were taken, the wheel was developing 11,000 horse-power. It will be observed that, with the exception of location No. 10, the readings at and near the outer diameter are markedly more than near the inner diameter. The effect is not, however, entirely due to the centrifugal force, but partly to the increased velocity of the water as it enters the wheel, and to its change of direction, which requires force, leading to increased pressure on the outer surface.

As the pressure and difference of head vary as the square of the velocity, it is readily seen that should the velocity at the entrance to the wheel-case be increased to say, 18 or 20 feet per second, the differences as shown by the gages of Fig. 3 would be multiplied by about 4, so that under the conditions of higher velocity the pressure within the wheel-case, near the tips of the vanes, would be 4 to 5 feet less than it would be on the outer circumference, and this loss of head would be quite a percentage of the total head operating on the wheel. This head is not, however, all lost, as part of it is accounted for in the velocity of the water as it enters the runner, but the other part of it, due to the impinging action of the water in turning through the volute casing is lost.

The wheel gates were also made unusually large in order to get full pressure at the vanes, the bonus clause being relied upon to recoup this expense also.

The draft tubes from the wheel were carefully worked out, so that the velocity of the water as it comes from the runner is decreased gradually until it is discharged into the tail-race. The velocity from the wheel and around the quarter turn is about 18 feet per second, while the velocity at the end of the draft tube as it enters the tail-race is about 3½ feet per second, the draft tubes being gradually enlarged to 10 feet diameter at the ends in the tail-race. The head due to the velocity of the flowing water as it reaches the runners is about 4½ feet. We make the draft tube a part of the turbine wheel and regain some of this 4½ feet of head by turning the water loose in the tail-race at a velocity of 3½ feet per second, with a corresponding velocity head of less than ½ foot. The amount of head which we regain by the draft tubes would, theoretically, be the difference between the 4 feet and ½ foot, or 3½ feet. The efficiency of the draft tube is, however, but 50 to 80 per cent., so that the actual head regained is about 2 feet, and the efficiency would be increased by the ratio of 2 feet to 135 feet, or 1½ per cent.

The diameter of the wheel-case at the entrance flange is 10½ feet. The volute casing is divided into five sections for shipping as well as casting reasons. All the pieces were made in loam from skeleton patterns.

DEFLECTION OF THE SHAFT.

The runner and shaft weigh approximately 20,000 pounds. The runner is of bronze cast in one piece. The shaft is of open-hearth forged steel with a coupling forged on one end. It is 16 inches in diameter through the large bearing, tapering up in the center of the wheel to 22 inches in diameter, and tapering down at the small end to 10 inches in diameter. The distance between the bearings is 27 feet. This is an unusual length, requiring a heavy shaft in the center to carry the weight.

The deflection of the shaft was calculated to be ⅛ inch, and after it had been completed and the wheel placed on it the actual deflection was carefully measured by means of a surveyor's level and found to be just the amount calculated. To provide for the deflection and to bring the wheel in the center of the casing the outer or tail-end bearing was raised ¼ inch, the main or generator-end bearing being on the level of the center of the bore

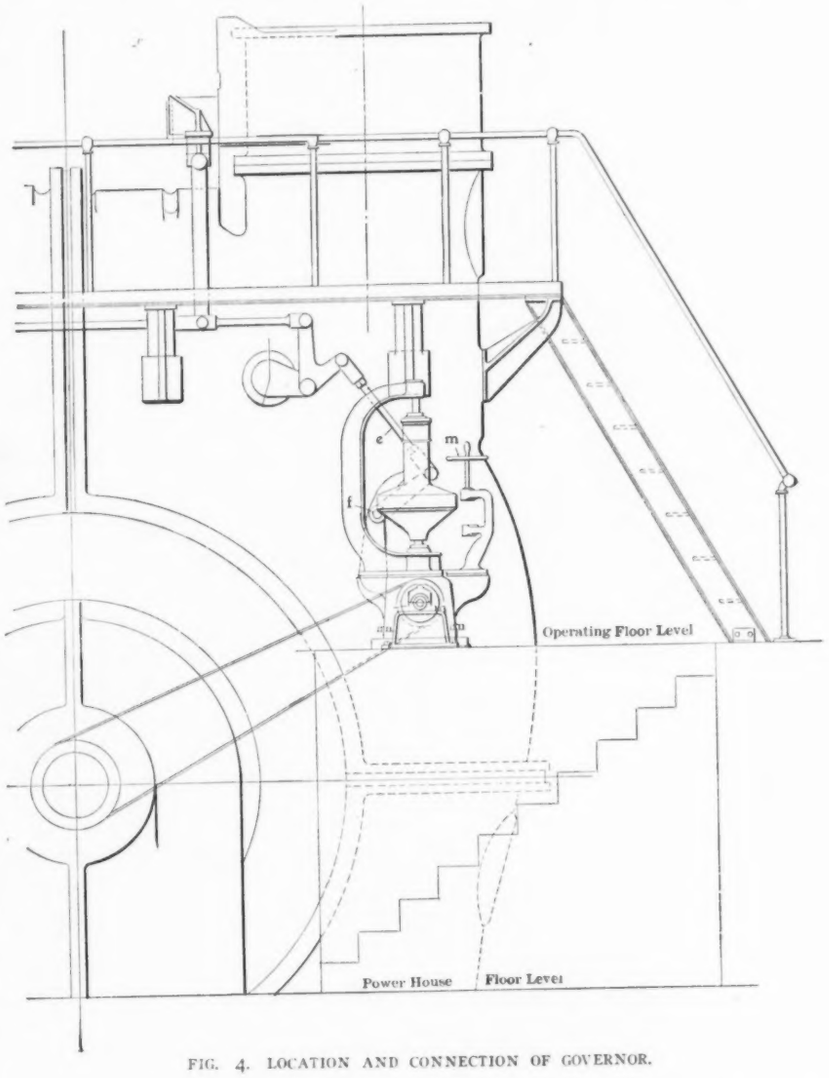


FIG. 4. LOCATION AND CONNECTION OF GOVERNOR.

of the casing, the object being to have the shaft horizontal at the generator-end bearing and thus bring the joint of the coupling vertical and so avoid strain on it due to the sag of the shaft. To provide for the resulting inclined location of the wheel runner, the top of the casing was tilted slightly toward the generator, thus bringing the plane of the casing into coincidence with the plane of the runner. The elevation of the tail-end bearing introduced a slight end thrust, but this is negligible in comparison with the thrust introduced by the unbalanced condition of the water. For this thrust bearings with lignum vitae blocks were introduced within the draft tubes and for them water is the only lubricant provided.

It is believed by many, though without reason, that under the conditions described the center of such a shaft will rise to true alinement when at high speed, an idea that is disproved, if it needs to be disproved, by this wheel. The clearance between the runner and the bore of the casing is 1/16 inch only, and there is no evidence that the runner has touched the casing at any point.

GATE-OPERATING MECHANISM.

The gates are of the shutter or window-blind type. There are 24 of them, each 24 inches wide. Forged-steel links at each side connect the vanes to a pair of steel rings which, by the rods *a b*, Fig. 3, are connected to 48-inch operating pistons, of which one is shown at *c*, by means of equalizing levers *d*, by which the same strain is brought on both rings, and the rings and pistons are prevented from canting. The pistons and their attached mechanism are in duplicate and may be used conjointly or separately, as the pistons have individually sufficient power to operate the gates. The operation of the gates by one piston necessitates that it be double acting, which will be seen to be the case. Water being incompressible, the large clearance space below the pistons does not lead to any loss.

The operation of the gates, whether by hand or the governor, is through these pistons. Fig. 4 shows the location of the governor, which is connected to the gate-operating mechanism by the rod *e* of Figs. 3 and 4. The system of levers and rods shown is in duplicate on the two sides of the turbine in order to give a balanced effort and prevent canting, the connection of the two sets being accomplished by the shaft *f* which extends through the wheel casing. The arrangement of rods *e* and shaft *f* differs in Figs. 3 and 4, due to a change in design, but this will not interfere with understanding the principle. The control of the pistons by the governor is through the floating levers *g h*, the two systems of levers being connected by the rod *i*. Referring to the right-hand gear, should rod *e* be raised by the governor the effect would be to raise the center of the floating lever *h*. The right-hand end of the lever being, for the moment, fixed, the left-hand end will be raised, thereby operating a piston valve on stem *j*. Water will then flow through pipe *k* and the valve to the lower side of the piston, which will rise and partially close the gates and also, the center of the floating lever being now held in position by the governor, lower its left-hand end and entirely close the piston valve, thus stopping the movement of the piston by cutting off its supply of water. Further rise of rod *e* will cause a repetition, and a drop of the rod a reversal of the movement of the piston. A glance at the connections will show that a movement of the governor which causes the piston valve of one side to rise will cause the other to drop, and therefore move the gate ring in the same direction. The movement of the levers and valves for either piston always takes place whether a given piston is at work or not, this being necessary to prevent locking of the non-acting piston by the water within its cylinder. The throwing of a piston out of action is effected by shutting the pressure water from it, a by-pass being simultaneously opened to permit the water to pass from one to the other end of its cylinder.

Hand operation of the gates may be effected by either hand wheel *l*, Fig. 3, or *m*, Fig. 4 which operate the floating levers and piston valves precisely as the governor does. To permit this the governor must be disconnected and the hand-wheel worm gear be connected, for which special provision is made.

Hand operation through the hydraulic apparatus is necessary because of the large amount of power required to operate the gates. The combined capacity of the two pistons is 90,000 foot pounds, which makes them the most powerful governor in existence. To exert this amount of energy would involve the work of a man for about half an hour, whereas by the hydraulic apparatus the gates may be closed in 1½ seconds. The long penstock, however, makes it unsafe to cut off the water as abruptly as this, the minimum time for the complete operation of the gates being adjusted to 5 seconds.

A notable feature of this contract is the fact that the wheel was designed, built and delivered on cars in four and a half months from the date of signing the contract.

During last winter the intake canal of the Niagara Falls Power Copany was kept free from floating ice by means of a trolley boat 25 feet long and 10 feet beam, operated by a Westinghouse single-phase railway motor supplied with current by double trolley wires running the length of the canal and provided with an over-running trolley and flexible cable. The ice was broken by the boat and driven toward the overflow near the head-house.

One American company sold 208,000,000 pounds of brass in 1905.

Mechanical Stokers for Locomotives.

The following extracts from a paper read by C. A. Kraft, of the Chesapeake & Ohio Railway, before the Traveling Engineers' Association refer to a class of inventions, which, in view of the great labor of firing some of the big modern engines, are, it seems to us, even more humane in their results than the automatic coupler.

The Victor locomotive stokers have been in operation since January 1, 1905, attached to locomotives with wide fire-boxes and to locomotives with long fire-boxes, used on all classes of passenger service.

Coal is distributed uniformly over the widest type of fire-boxes, with an entire absence of any blow holes, and the evenness of temperature secured has had a very marked effect on the cost of repairs to the locomotives. The stoker itself does not come in contact with the fire, and as it is strong and simply made the cost of maintenance is very slight. The continuous feeding of coal has a very marked effect upon the amount consumed. Run-of-mine coal is used, but it has been found that a good grade of slack will secure even better results, owing to the principle of feeding coal in small quantities widely distributed. Absence of dense volumes of black smoke is also very noticeable. An engine coming into a terminal with clean fires, such as are possible with this machine, is not called upon to go to the cinder-pit and dump its fires, but is backed into the roundhouse, where she holds steam for hours, until she is ready to go on her return run.

In the fastest and heaviest runs made, it is found that the steam gage shows a variation of not exceeding five pounds under ordinary conditions. Practical tests showing the capacity of the stoker have proven that it will feed, under normal conditions, a total of 18,000 pounds of run-of-mine coal per hour. With an unlimited coal-feeding capacity, therefore, and with such mechanism as will allow the fireman to regulate the stoker to existing conditions, the duties of the fireman are very much lessened and he has far more time to give attention to the running of the engine. It brings the fireman to the end of his day's work in a fresh condition, ready for extra duty should a call be made upon him. By relieving the firemen of the back-breaking, blistering work, the railroads are enabled to secure men of more than ordinary intelligence to do the work of firemen, and thus be provided with a high grade of men from whom to promote to engineers.

The stoker consists of the following essential parts: A main cylinder and a trough in which reciprocates a piston and plunger which, with a variable stroke, throws the coal to the different parts of the fire-box. This variable stroke is given to the plunger by means of a rotary valve, three separate steam ports leading

from said valve to the rear end of the cylinder, and three choke plugs—one for each of the said steam ports. A small controlling engine. A hopper with two spiral conveyors journaled in the bottom of the hopper-pan. The conveyors carry the coal to the front of the hopper onto the apron of the plunger, which, upon the return of the plunger, falls by gravity in front of it, giving a regular and uniform feed. The speed of the conveyors can be increased or diminished by giving more or less steam, as may be required, to the controlling engine. Each machine is supplied with a furnace door made to fit the standard door frame of the locomotive to which the stoker is to be attached. This door has an opening to receive the stoker through and is provided with suitable brackets for holding the machine in position.

Cast upon its inner side are curved lugs, which serve the purpose of hinges for a deflector for spreading each charge of coal over the width of the fire-box. The end of this deflector can be raised, if necessary, to aid in the distribution of coal by means of a set-screw directly under its center. It also has a small vertical sliding door for inspecting the fire, and the deflector can be turned up vertically and held in place by a latch to close the opening when the stoker is removed.

There is no doubt but that with the stoker in use very much less trouble with leaky flues will be found on account of maintaining a more even heat in the fire-box. The sheets of the fire-box will last longer for the same reason. It has been proven that corrugation in fire-boxes is due largely to the changes in the temperature.

It is my opinion that on the ordinary American type of engine there is no necessity whatever for the stoker, as the fireman has to be kept on the engine of course and the work is not such that an ordinary man cannot execute with ease. But with the long fire-box type of engine on a long run over a division comparatively free from grades, where the engine is loaded to its maximum capacity all the time, is where we believe the stoker will be found the most valuable, as a machine will not tire and consequently will enable the engine to carry the maximum pressure all the time and get the full benefit of the tractive power of the engine over a long continuous trip. This cannot be done with the hand-firing method on the type of engine mentioned above where the runs exceed seventy-five miles in length.

We have used the stoker on our large engines, with the fire-box 121⅝x41⅝ inches, and used run-of-mine coal over a hundred-mile division, and the engine steamed as well over the last ten miles as it did the first, and went into the terminal with about eight inches of fire on the grate and out again without the engine going over the ash-pit. All that was necessary with this engine at the end of the first thirty miles out of the second terminal was to shake the grates two or three times and the fire was almost as clean as when out of the first terminal. This engine really made two hundred miles without having her fire cleaned and steamed perfectly.

Blue Prints for Shop Specifications.

BY H. F. NOYES.

I was much interested in the article by L. F. B., at page 485, Vol. 29, Part 1, on the use of blue prints, particularly because we have found much of the practice he mentions useful in our shop, where we have a somewhat similar system. We have, however, recently found one feature sadly defective, and that was our method of ordering into the shop, from the warehouse and foundry, such materials as were needed, both for the finished-stock-room, and for machines on order.

Our shop has grown very rapidly within the past two years, and our method of taking care of this work could hardly have been called a system. For, while it was satisfactory before the business commenced to grow so fast, yet it was then not to be compared with the methods of many manufacturing plants of the same size, and would have been wholly useless but for the natural ability and energy of the chief cost clerk. He, with the assistance of one young man, and under the direction of the superintendent, looked after all getting out of material and parts of machines to fill orders, as well as finished parts for stock; kept the run of the finished stock, chiefly in his head; set the rates for a good portion of the premium system, and kept the cost of machines built, for a plant employing 150 to 200 hands, at that time, and building machine tools.

This cost clerk was a man of wonderful memory, and he was able to carry this work in this way successfully for several years; and I believe that for a plant of the size mentioned, we had about the simplest and least expensive cost system on record. The method of specifying was at that time from blue-print books, a book being made up for each type of machine, and containing often several sizes of that type, and each machine contained many mechanisms and parts which were used bodily in other types and sizes.

It can readily be seen that ordering from these books was not work that anybody could take up. It required a person with knowledge of drawings, knowledge of the shop methods, and knowledge of the machines.

All parts of the machines were given symbol numbers, and the symbol numbers were taken consecutively from a number of books corresponding with the types of machines built, but there were so many special machines, and special parts, differing perhaps only slightly from the regular, as well as the usual improvements to take care of, that these books were useless for the purpose of ordering, and recourse was had directly to the blue-print books.

As the business increased, and the number of types, sizes and changes in machines increased in proportion, some better method of handling this work was inevitable. The system finally adopted was not very different from many of those in common use, and in fact was gotten up after a study of those of many of the leading machine-tool manufacturers; and I will only touch on the drawing room end of it.

MACHINE NO. 23A 24A C.G.

MECHANISM R.H. Crank Carrying Fixture

4a²

	Dr. No.	Sym. No.	No. Pieces	Material	NAME OF PART	Sym. No. of Pieces Sup'sed
	3196	15173	1	C.I.	Intermediate Plate	
	3635	15327	1	"	Crank Carrying Fixture	
	"	15328	1	"	Clamp	
	"	17098	1	Stl.	Binding Bolt	
	3043	4716	2	"	Clamp Hinge Pin	
	1866	4897	3	"	Clamping Bolt	
	"	4970	3	"	" "	
	"	4898	1	"	Weight Clamping Bolt	

FIG. 1. SPECIFICATION SHEET.

We were called upon to make up specification sheets in such form that any clerk could, with a little instruction, order a machine from them, and that such portions of machines or mechanisms as were common to other machines could be readily and bodily picked out. Many smaller mechanisms were assembled complete in quantity in one erecting department, and kept in the finished-stock room until put into a machine on the erecting floor, and our sheets were arranged with reference to these mechanisms, usually each mechanism complete on one or two sheets, as the case might require.

Owing to the fact that a great many copies of each specification sheet were to be made, and that many sheets would be used continually, others only occasionally, and others only once, it seemed out of the question to use a printed form; so a form of tracing was made up; size 8x10 inches, suitable for envelope filing, one form of which is illustrated in Fig. 1.

Both blue prints and white prints are used, blue prints for the shop foremen, and white prints for the drawing room

and office. The tracings are filed in envelopes, one envelope containing all the tracings necessary for one size and style of machine. In case any part of a machine is special, sheets are made out for these special parts, and when filed away are kept in envelopes devoted to special parts. In case a part is changed, the sheet containing that part is marked obsolete, with the date, and filed away in envelopes devoted to such obsolete parts, and a new sheet put in its place. The change of parts involves a change in the symbol number of the piece or pieces affected, and often a change in the drawing number.

This change is usually taken care of on the tracing of the part by a new tracing if it is a material change, or by filing away in the drawing-room vault a blue print, called a record print, and then changing the dimensions on the tracing, if the alteration is only one of dimensions.

The specification sheets are classified in regular order according to the mechanisms or parts which they represent, somewhat in this form: Headstock, footstock, bed, pump, etc., and also include a sheet of accessories, on which are tabulated all loose parts such as wrenches, clamping bolts, hose, belting, etc. This latter sheet has been found particularly valuable in ordering out a new or special machine when there is likely to be a change in the set of parts supplied.

The specification prints are made up into books, which are supplied to the different foremen, inspector, shipping clerk, and to others having use for them; and they have proved particularly advantageous to the foremen of the erecting departments in ascertaining if they have all the necessary parts before starting to assemble a machine, or mechanism. For ordering into the shop, the 4x9-inch card Fig. 2 is used, the blue print of the part called for being pasted on the back of the card, and both follow the piece or lot either to the finished-stock room where it remains until the lot is exhausted; or to the erecting floor as the case may require. If the blue print is larger than the size of the card it is folded to that size, and held in place by an elastic band. The warehouse coupon at the bottom of this card is removed by the material clerk when filled out and returned to the order clerk and the date entered upon the following sheet shown in Fig. 3. This sheet is to assist the order clerk in getting out material, in ascertaining what and how many finished parts are in stock, and what it is necessary to order from the warehouse. This tells at a glance the condition of the machine work on any desired order, whether it is to be ordered from the finished-stock room, or warehouse; and as a book of copies of the necessary sheets to fill an order is given to the master mechanic and foremen of the erecting department, they are also aided in knowing where to look for these parts.

Amt. 50 S. O. 120
Size 2 7/8" x 12" Sym. No. 4306
Article Spindle Drg. No. 2302

To be Finished 4/6/06		Material Wanted 4/1/06		Material Received 4/2/06	
INSPECTOR	GOOD	OPERATION	Symbol	DEPT	Pro. Time ea.
A.H.	50	Rough Turn		A	20 m.
"	50	" "		A	40 m.
S.	48	Milling		B	10 m.
N	48	Drilling		C	15 m.
S	46	Rough Grind		E	20 m.
A.H.	45	Finish "		E	10 m.

WAREHOUSE COUPON
S. O. 120
Article Spindle Sym. No. 4306
Material Wanted
Amount 50 prs 12" long Wt. 595 lbs.
Material Cru. Steel Size 2 7/8"
Date Delivered 4/2/06
X.Y.
RETURN TO MATERIAL CLERK. Warehouse S.K.

FIG. 2. SHOP ORDER.

The warehouse man has a duplicate of the order sheet, and when the material is delivered he fills out the coupon and returns it to the order clerk, who enters the date on the sheet. The sheet shows at a glance what material is wanted, when it is wanted, and when it is received. The inspector's initials are entered on the sheet as he passes the work, and the number of pieces passed. The sheet also shows the time allowed for each operation, and the department in which it is done. The symbol letter is entered when the piece is finished, and the sheet is then filed away.

The card Fig. 2 is filled out by the order clerk, and is given to the man who is to do the work. It is then passed from one workman to another, and the time of each is entered on the card. When the piece is finished the card is returned to the order clerk, who enters the time on the sheet Fig. 3, and files the card away. The sheet Fig. 3 shows the number of pieces in stock, the number ordered, and the number finished. It also shows the time when the order was given to the shop, and when completed. The stock stub returned is entered when the stub is returned to the order clerk.

MACH. NO. 2-3-1

MECH. SPECIAL NARROW REST ARRANGED FOR RAD. DIA. HOLDER.

Old Dr. No.	New Dr. No.	Sym. No.	No. Pcs.	Material	NAME OF PART	No. Pieces Wanted	Stock	Date Ord. to Shop	Amount	Date Completed	Stock Stub Returned
2389		11489	1	Stl.	Spring	5	89				
2389		4578	1	"	Adjusting Screw	5	75				
"		4588	1	"	Plunger Adj. Screw	5	61				
"		4682	1	Stl.	Plunger for Narrow Rest	5	62				
3488		17051	1	Stl.	Locking Pin	5		5/10/05	10	5/5/05	5/20/05
"		17041	1	"	Lower Jaw Adj. Screw	5		"	10	5/7/05	"
"		17052	1	Stl.	Lower Jaw Screw	5		"	10	5/10/05	5/20/05
"		15283	1	Br.	Lower Jaw	5		"	10	5/5/05	"
2114		802	1	W.I.	Plunger	5	30				
"		803	1	"	Lower Jaw	5	52				
3586		13515	1	C.I.	Stat. Back Rest	5		5/16/05	10	5/15/05	5/20/05

FIG. 3. COMPLETE DATA SHEET.

A New Method of Reducing the Readings of the Pitot Tube—Comparison of the Weir and Pitot Tube.

BY W. M. WHITE.

Recent experiments of mine* having settled the dispute relative to the formula of the Pitot tube and shown that formula to be $v = \sqrt{2gh}$ without a constant, the use of that instrument is now fully justified. The object of this article is to present a new method of working up the readings of that instrument which is due to L. F. Moody, of the hydraulic department of the I. P. Morris Company, and which leads to a large saving of labor.

ARRANGEMENT FOR TAKING OBSERVATIONS.

Figs. 1, 2 and 3 show the arrangement of the apparatus in the penstock. The Pitot tube is at *a*, Fig. 1, where it is fitted to the riser pipe *b* which passes through a stuffing box in the penstock. The inner end of the riser pipe is guided by a crossbar within the penstock and the outer end by supports *d e* which, with the inner guides, are at right angles to the axis of the pipe in order that the Pitot tube may be parallel to it. A clamp *c* permits adjusting the tube to any part of the penstock diameter. Support *e* is graduated as shown, the extreme range of the gradutions being the diameter of the penstock. The graduations increase in fineness as the ends are approached to allow for the increased area value of a given diameter increment near the ends. The upper end of the riser pipe has an air cock *f* and a rubber tube connection *g* to the gage board *h*, shown in side view in Fig. 4, where also the arrangements are shown for taking the static pressure readings at four points in the circumference of the penstock, these connections being also shown at *i j k*, Fig. 3. It will be seen that by adjusting clamp *c* to the different divisions of its support, the Pitot tube may

*See *Journal* of the Association of Engineering Societies—1901.

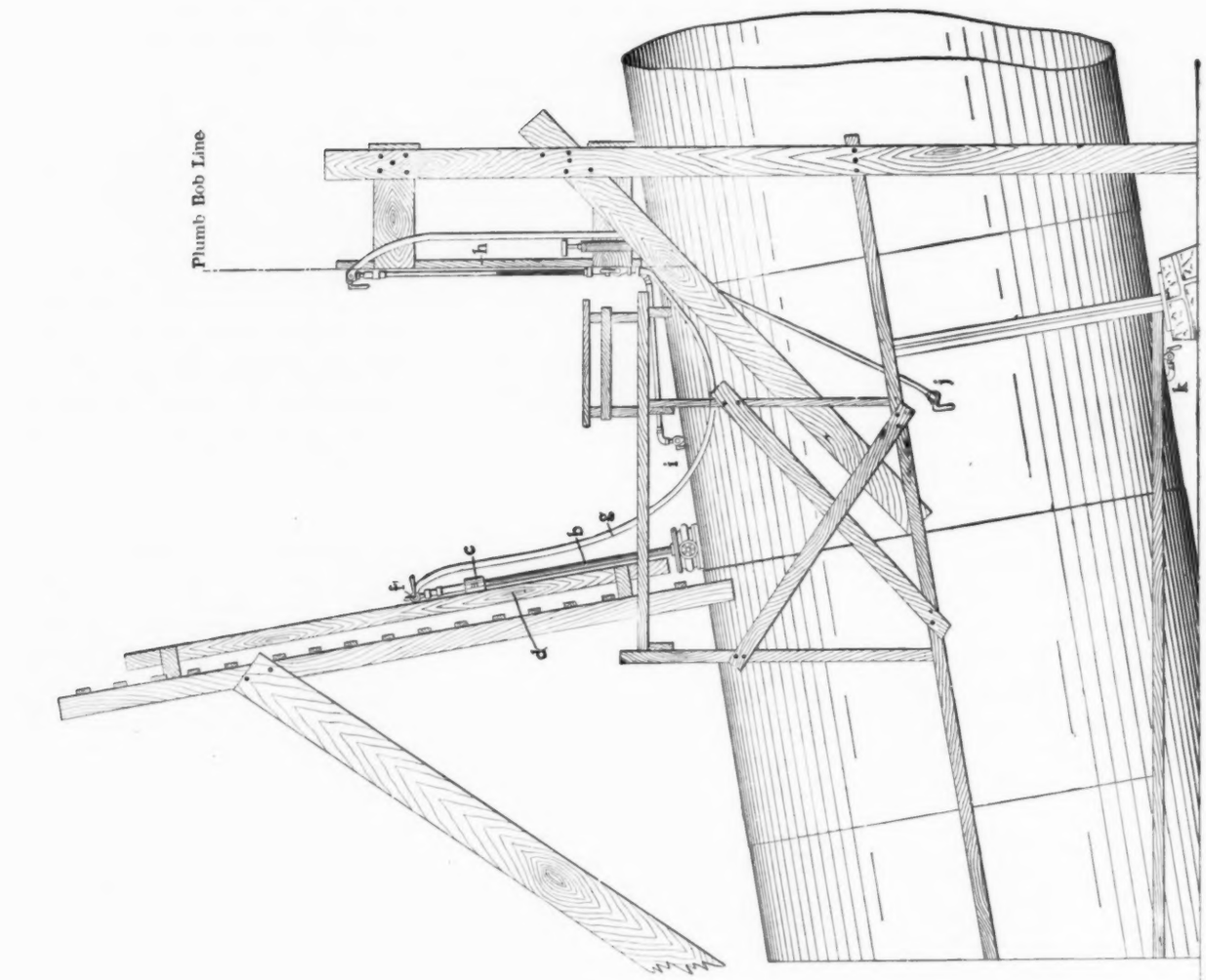


FIG. 3

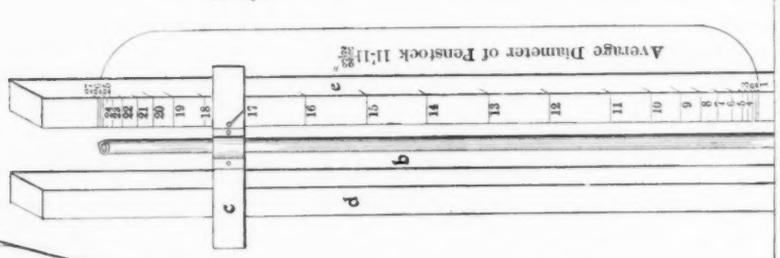



FIG. 2

ARRANGEMENT OF PITOT TUBE IN A PENSTOCK.

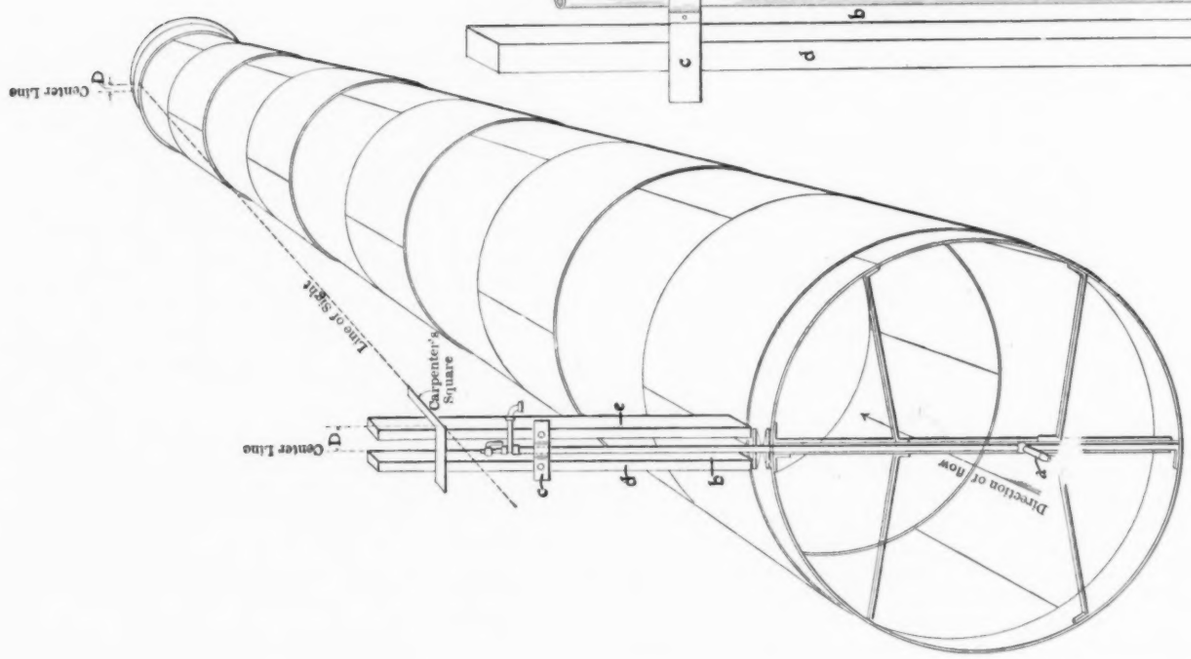


FIG. 1

be set to any point in the diameter of the penstock and the reading be quickly taken, and sets of readings for various tests under varying gate opening or other conditions may readily be obtained, and always for the same points in the diameter of the penstock.

The use of the carpenter's square Fig. 1 is in adjusting the guides *d e* truly square with the center line of the penstock. The tube *b* being correctly secured in clamps, parallelism of the Pitot tube with the center line at all adjustments is assured.

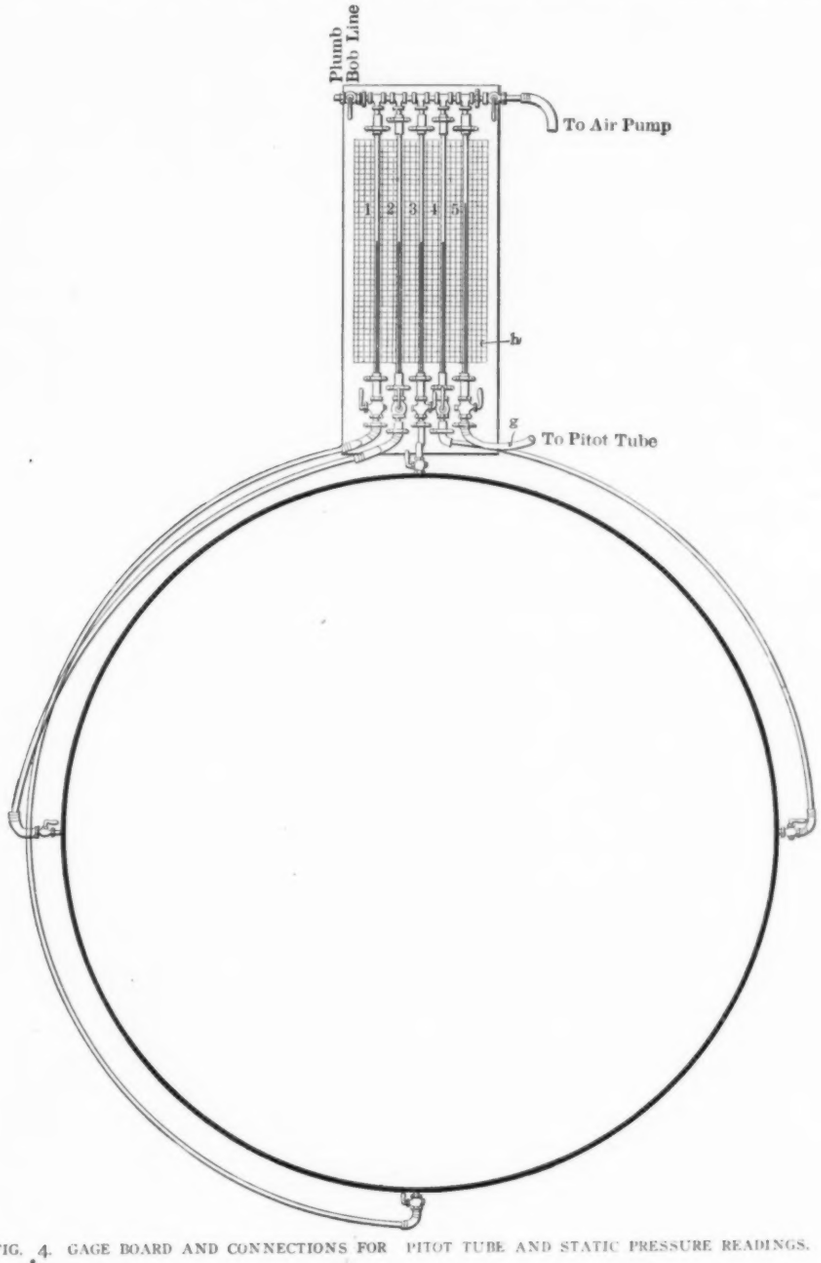


FIG. 4. GAGE BOARD AND CONNECTIONS FOR PITOT TUBE AND STATIC PRESSURE READINGS.

The object of the compressed air connections to the gage glasses is to bring the gage board down to a convenient level. Without this provision the board would necessarily be at about the level of the water in the head race, thus separating the observer of the glasses from the adjuster of the Pitot tube by an inconvenient distance, whereas the arrangement shown brings them into close proximity and even makes it practicable for one man to perform both functions. The reading which it is necessary to obtain for the velocity head is the difference between the static head and the Pitot tube readings, and since the arrangement shown insures the same air pressure in all the gage glasses this difference is not changed by the change in the location of the gage board.

REDUCING THE OBSERVATIONS.

The usual method in working up Pitot tube readings is to assign to each position an area, then determine by the Pitot tube the velocity at the center of that area, and then multiply the area by the velocity of that setting which gives the quantity, when the summation of the quantities for all the settings gives the total quantity flowing through the pipe.

When the number of sets of readings involved in a complete turbine test at several stages of gate are considered, it will be seen that this process involves a very laborious amount of computation, all of which is eliminated by Mr. Moody's method.

This method is shown in Fig. 5 and consists in using the horizontal scale for units of area instead of units of diameter. The length of the base line represents the total area of the penstock and the plotted points represent the readings converted from heads to velocities due to the heads and so located horizontally as to represent the area of the ring of which the tube stands in the center. Referring to Fig. 6, let *a b* represent two locations of the tube, location *a* being at the center of ring *c* of, say, half a square foot area, and location *b* being at the center of ring *d* also of, say, half a square foot area. The reading of the tube at *a* Fig. 6, converted to the velocity due to the head, is then

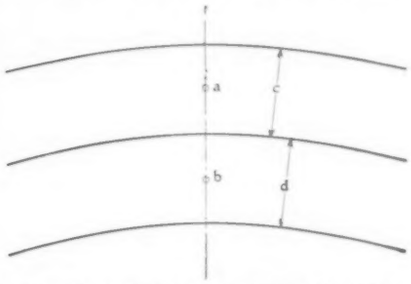


FIG. 6. CONVERTING DIAMETER TO AREA READINGS.

plotted at *a* Fig. 5, its distance from the vertical axis being, to scale, one half a square foot. Similarly the reading at *b* is plotted at *b*, Fig. 5, at a distance from *a* equal to another half a square foot and so on. Obviously the horizontal locations on Fig. 5, once determined for the graduations on the guide bars of Fig. 2, they may be marked on a strip of paper and numbered to correspond with the numberings on the guide bars, after which the plottings horizontally may be taken directly from the strip. The conversion of the heads as given by the readings to the velocities due to the heads is simply a matter of reference to tables. The readings plotted, it is only necessary to draw a curve through them and determine its area by a planimeter in order to find at once the total quantity of water per second without any calculation whatever. The scales commonly used for the diagrams are 1 inch = 5 square feet of area for the horizontal, and 1 inch = 1 foot velocity per second for the vertical, resulting in 1 square inch of planimeter reading for 5 cubic feet of water per second.

The results are extremely satisfactory and concordant. While individual curves have erratic points, as shown by the two

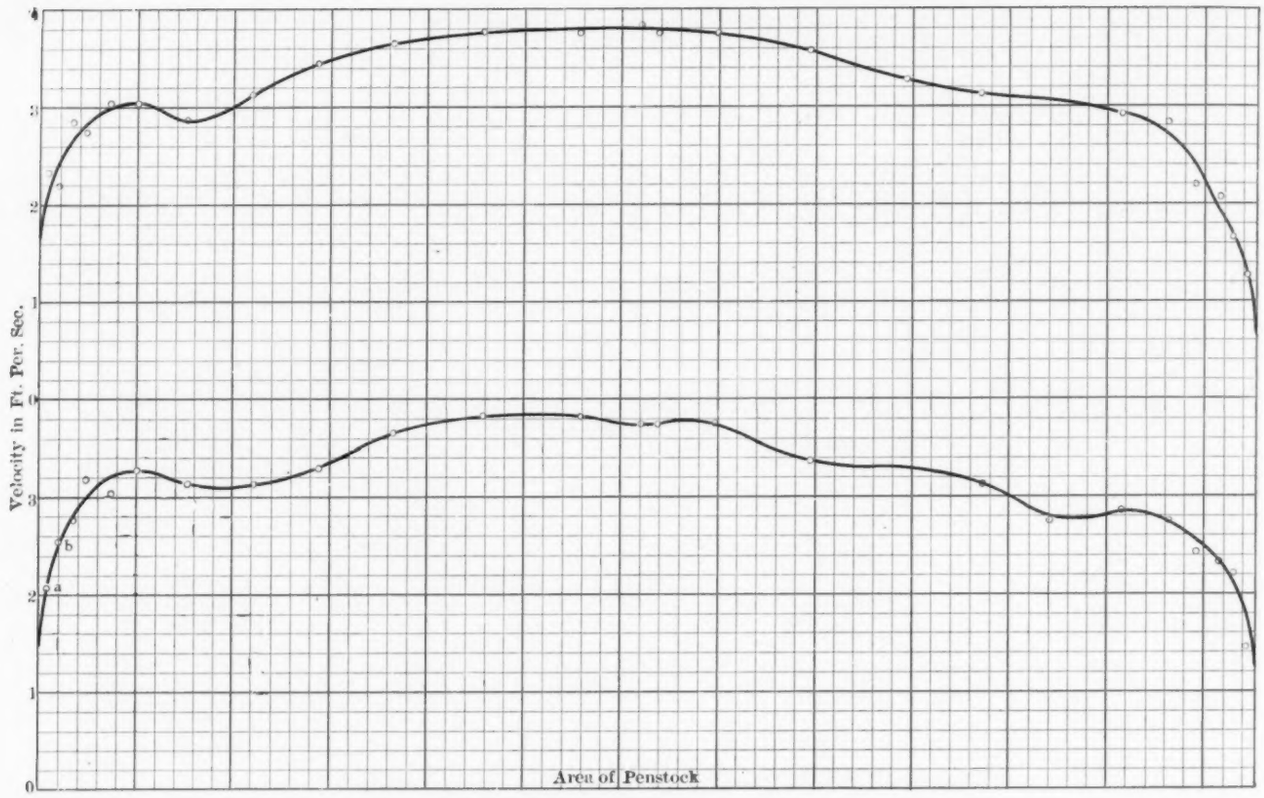


FIG. 5. MOODY'S METHOD OF REDUCING PITOT TUBE READINGS.

examples of Fig. 5, which were taken under identical conditions, the average of several leads to a fair curve as shown in Fig. 7, which is the average of eleven traverses taken by different observers. The satisfactory concordance of the results is shown by this test of a 12-foot penstock of which the eleven sets of readings were under identical conditions with the result that the extreme variation between the smallest and the largest result was less than one per cent.

PITOT TUBE AND WEIR RESULTS COMPARED.

Fig. 8 shows a weir as arranged in the tail race of the 6000 horse-power. I. P. Morris Company's turbine at the Shawinigan Water and Power Company's plant at Shawinigan Falls, P.Q., Canada.

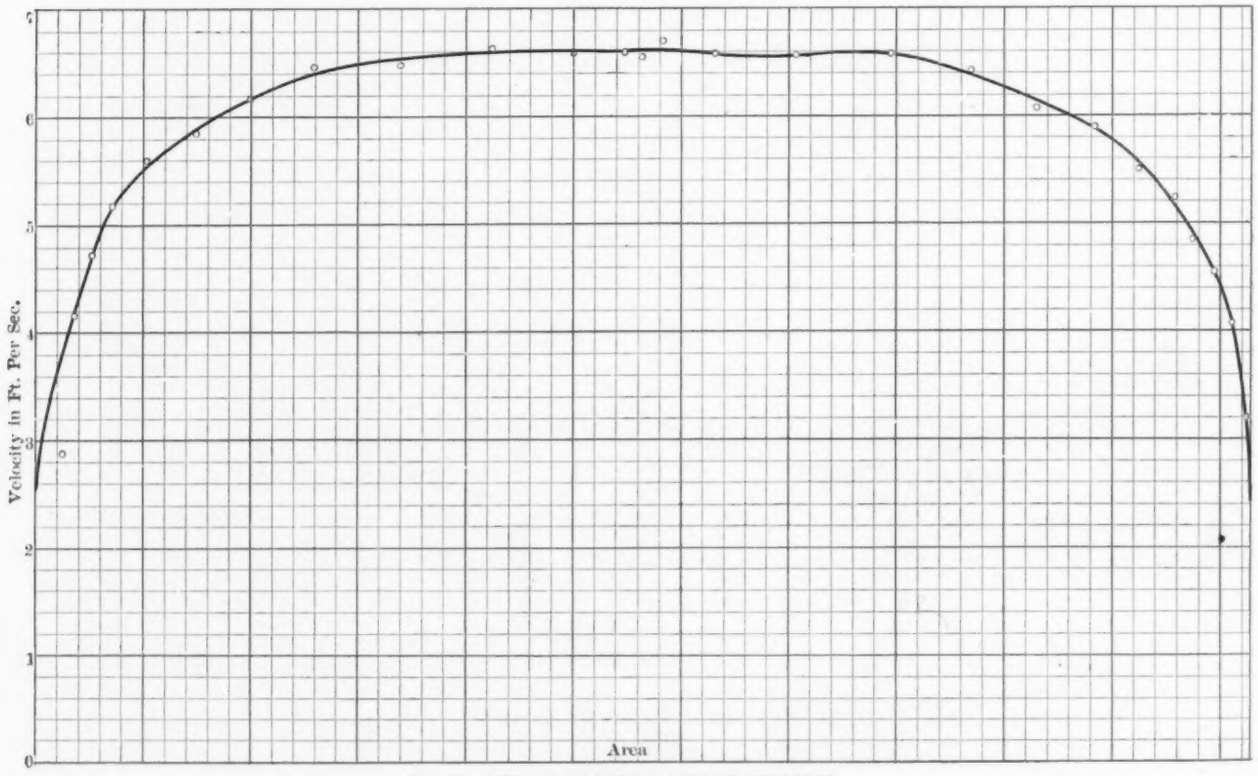


FIG. 7. AVERAGE OF ELEVEN SETS OF READINGS.

The width between the walls is 16 feet, and the crest of the weir was 16 feet long, so that it was a plain weir without end contraction. At the end of the weir notch boards were fitted to the notch in the wall, so that the water had a smooth passage at all points. The sides of the walls were of concrete and fairly smooth.

A hook gage was used to determine the quantity of water, but as the surface of the water was not entirely quiescent its hight was measured at several points across the surface of the water, all of these measurements being made six feet back from the crest of the weir. No weir box, or settling box, was used, the intention being to get the exact hight of the water and avoid any difference tending to raise and lower the water, which might occur in a quieting box. While observations were being made with the tapped holes of the penstock perfectly smooth, and also to have the plane of the point of the tube at right angles to the center axis of the pipe.

	Pitot Tube Results.	Results of Weir Calculations.		
Curve.		Francis.	Bazin.	Fteley & Stearns.
1	204.7	200.3	200.3	201.4
Average of 8, 9 & 10	263.6	257.3	261.3	262.3

COMPARISON OF WEIR AND PITOT TUBE RESULTS.

Time is not being lost in the construction of the New York, New Haven & Hartford Railroad Company's station at Cos Cob, Conn., for the generation of the electricity which is to run its trains into New York City. The building is reported as nearly ready for the installation of the turbo-generators, the first instalment of which is to aggregate 13,000 horse-power. It is stated that 1500 men are working night and day on the equipment of the line between Woodlawn, N. Y., and Stamford, Conn. It is possible that single-phase trains may be running before the close of the summer.

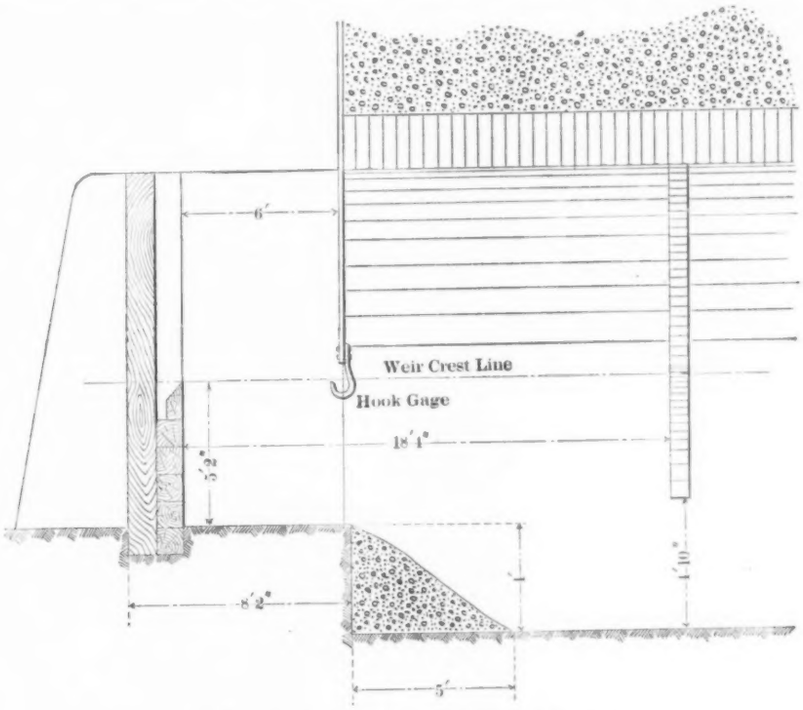


FIG. 8. CROSS SECTION OF WEIR IN TAIL RACE.

Pitot tube observers were constantly taking readings of the hight of the water over the weir.

The accompanying table gives comparisons of the results of Pitot tube and weir observations, the latter being reduced by three different formulas as indicated by the captions of the columns. The agreement will be seen to be very satisfactory, although the three weir formulas do not strictly agree among themselves. It will be understood, of course, that the same readings were entered into the three formulas. It is my belief that the Pitot tube is a more accurate instrument than the weir, and of course, the concordance shown would be impossible were the Pitot tube formula incorrect.

In connecting up and using the tube extreme care must be taken to have the

The largest paper-making machine ever constructed in Great Britain is one built for the Swedish Paper Mill Company for the production of two 75-inch sheets of paper, a total width of 150 inches. The paper will be run through the machine at the speed of 500 feet per minute. The entire machine weighs 550 tons and fills a shed 185 feet long. It will be driven by a 200 horse-power steam engine.

Worm-Gear Design—II.

BY A. M. SOSA.

The accompanying table has been prepared as explained at page 709. In order to familiarize the reader with its application, some considerations and practical examples will be convenient. Fig. 1 is an ordinary detail drawing of a worm, omitting those dimensions which are not needed in the present consideration. The angle of the thread is useful in the shop, and more so when these worms are milled. Moreover, the designer uses this angle, and for these reasons it should be on every drawing. The capacity for doing work, or its rated horse-power, is a valuable reference for the drawing room, and should be included in the details. It will be noticed that the difference between the maximum and minimum allowable power transmitted by a worm at different speeds is comparatively small. If we assume two speeds for the worm shown on Fig. 1, 500 and 25 revolutions per minute, or better, measuring this velocity in lineal feet, assume 500 and 25 feet of worm pitch-line velocity, we will have

$$\left\{\begin{array}{l} 500 \times \tan. 20^\circ = 182 \\ 25 \times \tan. 20^\circ = 9 \end{array}\right\} \text{ feet}$$

for the corresponding periphery velocities of a wheel in mesh with the worm.

Averaging the figures for 19 and 21 degrees and 9 feet velocity to obtain the figure for 20 degrees at 9 feet, and, similarly, averaging the figures for 19 and 21 degrees for 172 and 192 feet velocity to obtain the figure 20 degrees at 180 feet, we obtain 360 and 19 respectively as the values of f. Substituting these in $W = 5\,p\,d\,f$, the safe loads at both speeds are:

$$\left\{\begin{array}{l} W = 5 \times 1 \times 3.5 \times 19 = 332 \text{ pounds.} \\ W = 5 \times 1 \times 3.5 \times 360 = 6305 \text{ pounds.} \end{array}\right.$$

Multiplying these loads by their respective velocities, previously obtained:

$332 \times 180 = 59{,}760$ foot-pounds.
$6305 \times 9 = 56{,}745$ foot-pounds.

or, from 1.8 to 1.7 horse-power.

The approximate efficiencies estimated for high and low speeds are given on the first two lines of the table. In this case it ranges from 85 to 51 per cent., or a mean of 63 per cent. From the designer's standpoint it is convenient to include the efficiency of these gears in the rated horse-power in order to readily determine the relative stresses on the parts immediately connected, such as the worm shaft and other gears; this gives

$$\frac{1.75 \times 100}{63} = 2\tfrac{3}{4} \text{ h p. input.}$$

The values obtained by this method are meant for constant work, as in the drive of a lathe. In reciprocating machines, for instance planers, where the motor may indicate 20 horse-power at the moment of reversing, and only 4 or 6 during the strokes, the last figures are mainly taken into consideration. The heavy strains being of a short duration, the action of heat-generating is not permanent, and

there is time, during the length of strokes, for cooling, though some allowance for this seems necessary. For such movements as elevating the cross-rail of a boring mill, where the gearing is in use only for a minute or two, and at long intervals, it is possible to overload a worm perhaps two or three times its rated capacity.

Once having determined the rated capacity of a worm, the designer will consider the wheel as if it were a spur gear, keeping the load under the breaking strength of the teeth. The failure of these gears by breaking is a different thing from their failure by heating and cutting.

Fig. 2 shows a worm similar to Fig. 1, but with two threads instead of four, and consequently of smaller angle of thread. The net capacity of the latter is about one-half that of the former, but its mean efficiency being lower, its rated horse-power input is more than half that of the first one.

In these two examples the length of spiral is the same, within four per cent., and so is the rubbing velocity for both, at the same worm velocity, and, being of equal pitch, the projected area of contact in both cases is sensibly the same. This being the case, the safe working load is the same for both worms. The lead is 2 inches instead of 4, and the wheel velocities are 90 and 4½ feet for 500 and 25 feet velocities of worm. The wheel velocity being one-half that of the first example, the power transmitted has the same ratio. In both cases, the pressure per square inch of projected area times the rubbing speed is the same, and with the same loss, measured in *foot-area* of rubbing friction, the power transmitted is in the ratio of two to one. This is due to the angle of thread, and to the increase of efficiency with increase of angle.

The active force of the worm at the pitch line is of course proportional to the horse-power input and so is the torque on the worm shaft. The pressure normal to the spiral is, however, altered somewhat as noted in the formulas of the original analysis.

THE TABLE AND ITS USE.

The table has been made with the idea of obtaining directly the safe load of a given gear, or vice-versa, and of computing the diameter and lead of a worm that will carry a given load at a given speed, as in spur gears, this being more in line with the common practice in machine design. A practical example will make the usefulness of the table more clear.

Suppose a lathe is to be driven by a worm and worm wheel, the wheel being of the full-swing diameter, the cutting speed at full swing 20 feet per minute and the pressure on the tools 10,000 pounds.

We have to compute the diameter, pitch, and number of threads of a worm that will carry a load of 10,000 pounds at a wheel velocity of 20 feet. First we determine the pitch and face of a spur gear that will carry the given load. Let us assume 1½ inches pitch, 5 inches face. The face of a worm wheel is one-fourth the circumference of the worm, consequently we have as a preliminary assumption, 1½ inches pitch and 6 inches pitch diameter for the worm. Substituting in the formula $W = 5\,p\,d\,f$ we have:

$10{,}000 = 5 \times 1.5 \times 6 \times f$, $f = 222$

giving $f = 222$

A glance at the table will show that for

Efficiency Min.	.08	.09	.12	.15	.18	.22	.24	.28	.30	.33	.35	.38	.41	.44	.47	.50	.52	.55	.58	.60	.62	.63	.64	.64	.65	At 9 ft. Worm Velo.
Efficiency Max.	.53	.57	.48	.58	.63	.68	.70	.72	.75	.77	.78	.80	.81	.82	.84	.84	.86	.86	.87	.88	.89	.90	.90	.91	.91	At 400 ft. Worm Velo.
Tan. α =	.017	.026	.035	.052	.070	.087	.105	.123	.140	.158	.176	.194	.231	.268	.306	.344	.384	.445	.510	.577	.649	.726	.809	.900	1.000	
α =	1°	1½	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	13°	15°	17°	19°	21°	24°	27°	30°	33°	36°	39°	42°	45°	

Values of f

Worm-Wheel Pitch-Line Velocity in feet per minute—S																											
9	20	25	39	57	76	95	113	132	150	168	188	205	242	275	312	345	376	425	470	515	552	560	630	650	670	9
13	13.5	20	27	40	58	66	78	92	104	116	130	142	168	192	216	240	262	296	328	358	408	435	460	475	505	13
17	10.3	15.3	20	31	44	51	60	70	80	92	100	109	128	146	166	184	201	237	253	277	298	319	327	338	359	17
26	6.8	10	13.5	20	27	34	40	47	53	59	65	72	85	96	109	121	132	149	165	180	193	207	220	227	241	26
35	5	7.5	10	15	20	25	30	35	40	44	49	54	63	72	83	92	100	112	125	136	143	153	162	167	177	35
44	4	6	8	12	16	20	24	28	32	35	38	43	50	57	65	72	78	88	98	106	113	121	128	132	140	44
52	3.5	5	6.7	10	13.5	17	20	24	27	30	33	36	43	49	55	61	66	75	83	90	96	103	109	112	118	52
62		4.3	5.7	8.5	11.3	14	17	20	23	26	28	31	36	41	46	51	56	63	70	76	81	87	92	94	100	62
70		3.7	5	7.5	10	12.5	14.8	17.5	19.9	23	25	27	32	37	42	46	50	57	63	68	72	77	82	85	90	70
80		3.5	4.5	7	9	11	13	15.5	18	19.9	22	24	28	31	35	39	43	48	53	58	62	66	70	73	76	80
88			4	6	8	10	12	14	16	18	19.8	22	26	29	33	37	40	45	50	54	58	62	65	67	71	88
96			3.7	5.5	7.3	9.2	10.8	12.8	14.6	16.4	18	19.8	24	27	30	33	37	41	46	50	53	56	60	62	65	96
113			3.6	4.7	6.3	7.8	9.3	10.8	12.5	14	16	17	19.5	23	26	28	31	35	39	42	44	47	50	52	55	113
135				3.9	5.2	6.5	7.6	9.2	10.4	11.7	13.3	15	17	19.5	22	25	27	30	33	36	38	40	43	45	47	135
152				3.6	4.7	5.7	6.8	8	9.3	10.4	11.8	12.8	15	17	19.3	22	25	28	31	33	35	37	39	41	43	152
172					4	5	6	7.3	8.2	9.2	10.2	11.3	13	15	17	19	21	23	26	28	29	31	32	33	35	172
192					3.7	4.6	5.6	6.4	7.3	8.4	9.2	10.2	12	13.6	15.5	16.7	18.5	21	23	25	26	28	30	31	33	192
222					3.3	4	4.7	5.5	6.3	7.2	8	8.8	10	11.8	13.5	14.6	16	18.2	20	22	23	24	26	27	29	222
255						3.6	4.2	4.8	5.5	6.2	7	7.6	9	10.4	11.7	13	14.4	16.2	17.8	19	20	22	23	24	25	255
288							3.7	4.3	4.9	5.5	6.3	6.8	8	9.2	10.4	11.7	12.8	14.5	16	17.3	18	19	20	21	22	288
324								3.8	4.3	4.9	5.5	6	7.2	8.3	9.3	10.5	11.5	13.3	14.7	15.8	16.7	17.6	18.6	19.2	20.3	324
362								3.4	3.9	4.4	4.9	5.4	6.4	7.4	8.4	9.3	10.4	11.8	13.2	14.3	15	16	17	17.6	18.6	362
406									3.5	3.9	4.3	4.8	5.7	6.6	7.5	8.5	9.3	10.7	11.8	12.8	13.5	14.4	15.4	16	17	406
454										3.5	3.9	4.3	5.1	6.3	7.2	7.8	8.5	9.5	10.8	11.8	12.3	13.2	14	14.5	15.5	454
500											3.5	4	4.6	5.3	6.4	7.2	7.8	8.8	9.6	10.6	11.3	12	12.8	13.2	14	500
π tan. α	.055	.083	.110	.165	.220	.275	.330	.385	.442	.497	.554	.610	.726	.842	.961	1.08	1.21	1.40	1.60	1.81	2.04	2.28	2.54	2.83	3.14	

Worm Pitch-Line Velocity in feet per minute — 3000, 2000, 1500, 1000, 750, 500

S — 50, 100, 200, 300

W = 4 or 5 × d × p × f.

$$f = \frac{10{,}000}{S \cot.\ \alpha \left[\cos.\ \alpha \times \tan.\ (\alpha \times \beta)\ \sin.\ \alpha \right]}$$

W = Safe load on worm wheel tooth, in pounds. Material, cast iron.
S = Speed of worm wheel in feet per minute.
α = Angle of thread. β = angle of friction.
f = Factor, depending on the values of α, S.
d = Pitch diameter of worm.
p = Pitch in inches.
Lead = $d \times \pi$ tan. α. S = tan. α × worm pitch line velocity.
Factor 4 for cast iron, and 5 for steel worms.
Pressure per inch of projected area = 8 f., nearly.

CONSTANTS FOR THE DESIGN OF WORM GEARS.

a wheel velocity S of 20 feet, the value 222 lies between the angles of 21 and 24 degrees. The value $\pi \tan. \alpha$ between these angles is about 1.3, which multiplied by the worm diameter gives the lead:

$$\text{Lead} = d \pi \tan. \alpha = 6 \times 1.3 = 7.8.$$

Answer:

Pitch dia = 6 inches
Pitch = 1½ inches

$$\text{No. of threads} = \frac{7.8}{1.5} = 5.2$$

or, taking the nearest whole number, 5.

Using 2 inches pitch instead of 1½, we will have:

$$10{,}000 = 5 \times 2 \times 6 \times f$$

giving $f = 166$

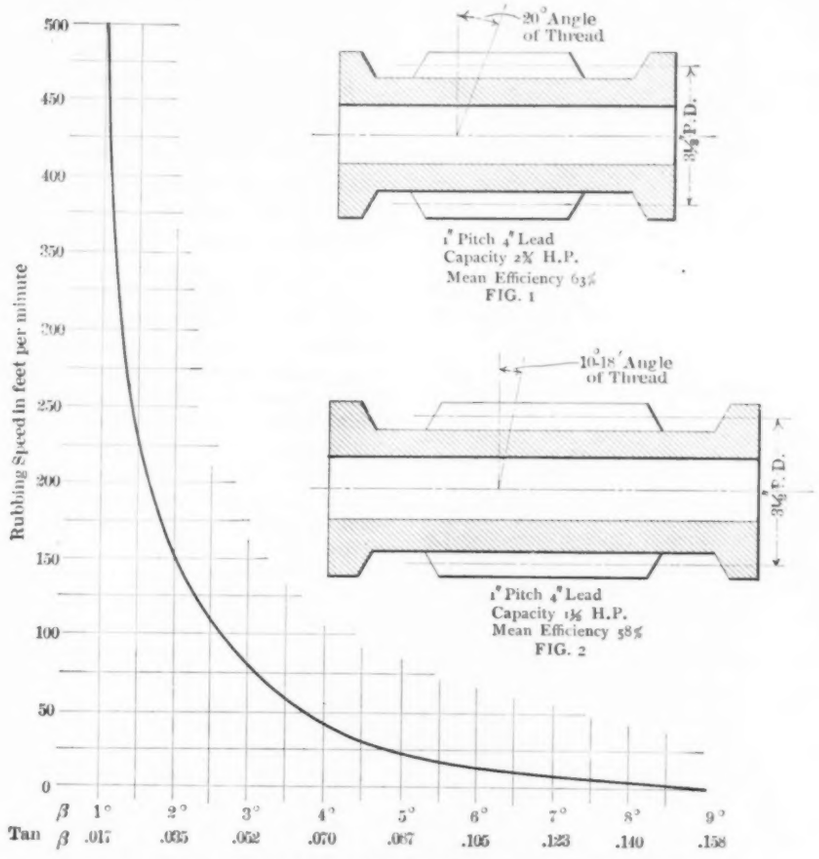


FIG. 3. RELATION OF ANGLE OF FRICTION AND RUBBING VELOCITY.

Answer:

Pitch diam. = 6 inches
Pitch = 1½ inches
No. of threads = 4

If the diameter were considered too small to admit a sufficiently heavy shaft, or because of some other consideration, it would become necessary to alter one of these figures and make a second trial.

USE OF THE WORM INSTEAD OF THE WORM-WHEEL VELOCITY.

In the previous example, when locating the value 222 on the table, it will be seen, by following the diagonal that crosses this point, that the worm pitch velocity is about 50 feet. The rubbing velocity is somewhat greater, but low enough to allow of a heavy load. The object in increasing the angle is to keep the rubbing velocity low enough so that the product pressure per inch times rubbing velocity shall not exceed the limiting constant.

The diagonals on the table may be used when figuring from the worm instead of the wheel velocity. Suppose we want to compute the load of a given worm at a given speed, of say, 1¼ inches pitch diameter, ¾ inch pitch, 1½ inches lead, at 100 feet pitch-line velocity. The angle of the thread in this case is 21 degrees nearly. On the table where the line of 100 feet worm pitch-line velocity crosses the 21 degrees column, the value of f is found to be 78. Substituting in the formula $W = 5 p d f$ we will have

1" Pitch 4" Lead
Capacity 2¾ H.P.
Mean Efficiency 63%
FIG. 1

1" Pitch 4" Lead
Capacity 1⅛ H.P.
Mean Efficiency 58%
FIG. 2

$W = 5 \times .75 \times 1.25 \times 78 = 365$ pounds for the safe load on the tooth of a wheel in mesh with said worm, when the pitch-line velocity of the worm is 100 feet, or about 300 revolutions per minute. Following the horizontal line from the value found (78), we find 44 feet to be the worm-wheel pitch-line velocity in this case. If the diagonal crosses exactly the center of the little square where the value of f is found, it is exact and so is the wheel speed. In the above example the diagonal crosses that little square slightly above the center, which means a wheel velocity slightly less than 44 feet, 38 feet in this case. For the same reason the safe load obtained is somewhat lower than what it should be. More accurate results can be obtained with this table when figuring from the wheel velocity.

COEFFICIENT OF FRICTION.

The laws of friction of lubricated surfaces approximate those of solid friction as the lubrication becomes more imperfect, or as the pressure per inch increases; and it approximates the laws of fluid friction as the surfaces become more flooded with oil. See Kent's "Pocket Book," pages 928, 929. From the laws of unlubricated friction I quote: "The coefficient of unlubricated friction decreases materially with velocity, is very much greater at minute velocities of $o+$, falls very rapidly with minute increases of such velocities, and continues to fall much less rapidly with higher velocities up to a certain varying point, following then the laws of lubricated friction." In the table the diagonal that corresponds to 500 feet worm velocity crosses the table from corner to corner. The values on this line give a pressure per inch of about 150 pounds. The values above this line give greater pressures, and those below, smaller ones. The rubbing speeds are inversely proportional. For values below this line we may assume perfect lubrication and a coefficient of friction of 0.018, which corresponds to an angle of friction of about one degree. For values above this line the coefficient of friction is a variable quantity, increasing its value and approaching the laws of solid friction up to the angle of rest, generally accepted to be 12 degrees or more.

In Fig. 3 the curve shows the increase of the angle of friction approximating these laws. For higher speeds than those shown, the coefficient of friction is expected to commence increasing its value again, approaching the laws of fluid friction, "proportional to the square of relative velocity." See Kent, page 931. The values of β and its tangents, given at the bottom of Fig. 3, are the angle and coefficient of friction for rubbing velocities up to 500 feet, used in computing the first two lines of the table.

COMPARISON WITH MR. RAEBURN'S DIAGRAM.

In a recent article at page 505 is a diagram for computing the horse-power of worms, by William H. Raeburn, which would show that a worm similar to Fig. 1 above, but of 1⅛ inches instead of 1 inch pitch, will transmit 22 horse-power—a result about ten times as great as the one obtained from my table. I have taken from the same diagram the values given for a 3-inch worm, 1 inch pitch, single, double and treble, and compare the results as follows:

single, capacity, 5¾ h.p. at 600 r.p.m.
double, capacity, 11½ h.p. at 900 r.p.m.
treble, capacity, 17 h.p at 3300 r.p.m.

The corresponding rubbing velocities are:

for the single, 520 feet;
for the double, 710 feet;
for the treble, 1610 feet.

The periphery speeds of the wheels in

gear with these worms would be:

for the single, 55 feet;
for the double, 150 feet;
for the treble, 825 feet.

The respective loads on the teeth, obtained from the horse-power given would be:

for the single, 3450 pounds;
for the double, 2530 pounds;
for the treble, 680 pounds.

Dividing these loads by the projected area of contact, which is about 1.4 square inches, the pressure per inch would be:

on the single, 2460 pounds;
on the double, 1810 pounds;
on the treble, 485 pounds.

The product, pressure per square inch times the rubbing velocity for each one, would be:

for the single, 1,280,000;
for the double, 1,283,000;
for the treble, 1,270,000.

The above figures have been obtained by the calculating rule, but the last products are strikingly even, and indicate that the same or similar principles are at the bottom of both systems.

These last figures show a limiting constant of over one million, or ten times as great as the one I have used.. I have tried a few other examples from the diagram mentioned, and I find that this value varies. The smallest that I found was 500,000 for 6½ diameter, 1⅛ pitch single.

The experiments made by Mr. Christie, and published by F. A. Halsey in his book on "Worm and Spiral Gearing," at page 37, supply excellent data for comparison.

In order to compare with the results obtained by Mr. Christie, I have reduced his figures as given in the book to horse-power, and obtain the following results:

	Average from Christie's Test:	From diagram:
2⅞ pitch dia. 1 inch pitch. 1 inch lead.	¾ h.p. at from 96 to 320 r.p.m.	5¾ h.p. at 680 r.p.m.
2⅞ pitch dia. 1 inch pitch. 2 inch lead.	1½ h.p. at from 96 to 205 r.p.m.	11½ h.p. at 950 r.p.m.
4⅛ pitch dia. 1¼ pitch. 2½ lead.	1⅓ h.p. at from 215 to 498 r.p.m.	9⅓ h.p. at 300 r.p.m.

The results of Mr. Christie's tests compare well with the values obtained from my table. The values from Mr. Raeburn's diagram are again about ten times greater.

To make steam fitters' cement one part by weight of rubber or gutta percha should be dissolved in sufficient carbon disulphide to give it the consistency of molasses, and it should then be mixed with six parts by weight of linseed oil and left exposed to the air for twenty-four hours, and then mixed to a putty with red lead. If oxide of iron may be used in place of red lead, a less brittle cement will be obtained.

Engineering Reminiscences.*

BY CHARLES T. PORTER.

The following is a story with a moral. The moral is, working to gages is an excellent plan providing the gages are mixed with brains. No manufacturing system is perfect that is not fool-proof. If a mistake is possible it is generally made.

MISUSE OF GAGES.

A company of English capitalists were spending a good deal of money on the west coast of South America in building railroads into and over the Andes. One of these roads was intended to reach a famous silver mine, from which the Spaniards, two or three hundred years before, had taken large quantities of the precious metal, but which had long ago been drowned out and abandoned. The railroad was to take up pumping machinery by which the mine could be cleared of water and to bring down the ore in carload lots. For some purpose or other they wanted a stationary engine in those high altitudes, and their agent in this country ordered one from me. I was having my fly-wheels and belt-drums cast by Mr. Ferguson, whose foundry was on 13th street, west of Ninth avenue, some seven miles distant from my shop in Harlem. He had a wheel lathe in which I could have them turned and bored and they were bored to gages and shipped to their destination. This time I had two wheels to be finished, so I sent the gages with a tag attached to each describing the wheel it was for, but neglected to go and make a personal inspection of the work. Some months after I received a bitter letter from South America complaining that they found the wheel had been bored half an inch smaller than the shaft, and that they had to chip off a quarter of an inch all around the hole where the barometer stood at 14 inches and physical exertion was something to be avoided. The case was somewhat relieved by the fact that I always cored out a larger chamber in the middle of the hub for the purpose of getting rid of a mass of metal which would cause the hub to cool too slowly, finishing only a length of two inches at each end of the hub, which was 10 or 12 inches long. As the engine had been paid for on shipment and ran well when put together, there was no great harm done, but I was sorry for the poor fellows who had to do the work; this was the only misfit I can recall in my whole experience.

A MOLDER'S PIECE WORK.

Mr. Ferguson told me the best piecework story I ever heard. He said he had a contract for making a large number of the bases for the columns of the elevated railroad; these castings were quite large and complicated. He gave the job to his best molder but the man could turn out only one a day. He thought it was slow work and spoke to him about it, but he protested that was all he could make. Mr. Ferguson found he could never complete his contract at that rate and as he was paying the man three dollars a day, he told him he would pay him three dollars for each perfect casting and asked him to do his best and see how many he could turn out. The man employed a boy to help him and by systematizing his work he turned out six perfect castings every day and drew his eighteen dollars with supreme indifference. This is a big story to swallow, but the incident was then recent, I had the story from Mr. Ferguson himself, and he was a sterling, reliable man, so that there could be no doubt as to its absolute truth.

EXPERIENCE AS MEMBER OF BOARD OF JUDGES.

One day in April I was surprised to receive by mail a commission as a member of the Board of Judges in Group Twenty of the Philadelphia International Exhibition. I was at a loss to know how I got it, but learned afterwards that I had been appointed on the recommendation of Mr. Holley, who was consulted by the commissioners about the judges in several groups. The exhibition was opened on May 1, but the judges were not to assemble until the 24th and on that day we had quite a ceremony in the judges' hall. The American judges were seated at one side of the hall and rose to receive the foreign judges who filed in from some place where they had been corralled, while a fine band played the national airs of all nations that had any airs. After a time spent in welcoming and responsive addresses, we were marched to a large café and given luncheon, after which the different groups were organized. There I had the pleasure of first meeting Mr. James Moore, of Philadelphia, the eminent builder of rolling-mill machinery; also Prof. Reuleaux, of Berlin, and Colonel Petroff, of St. Petersburg; I observed that both these foreigners used the English language more accurately than I did. We organized by the election as president of Horatio Allen, formerly president of the Novelty Iron Works (then extinct), he being the oldest and the biggest man among us. Under Mr. Allen's administration we had a fine illustration of how not to do anything—of endless preparation and never getting to work. He had an interminable series of subjects for discussion and he was accustomed to say: "These questions must be all settled before we can enter upon the discharge of our duties, gentlemen." This had the effect upon our foreign judges that they absented themselves from our meetings. I remember Mr.

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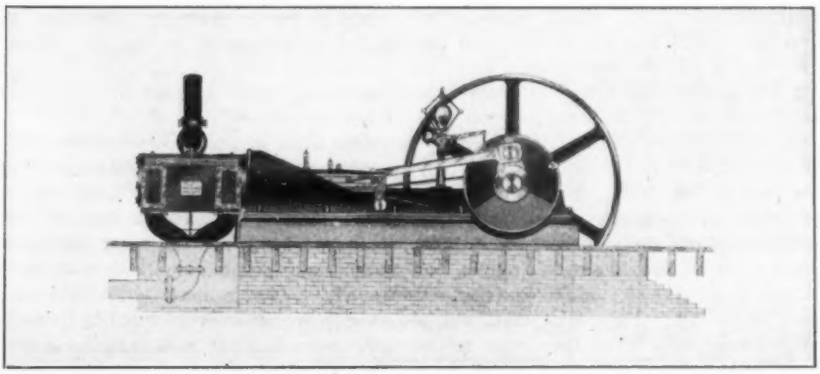
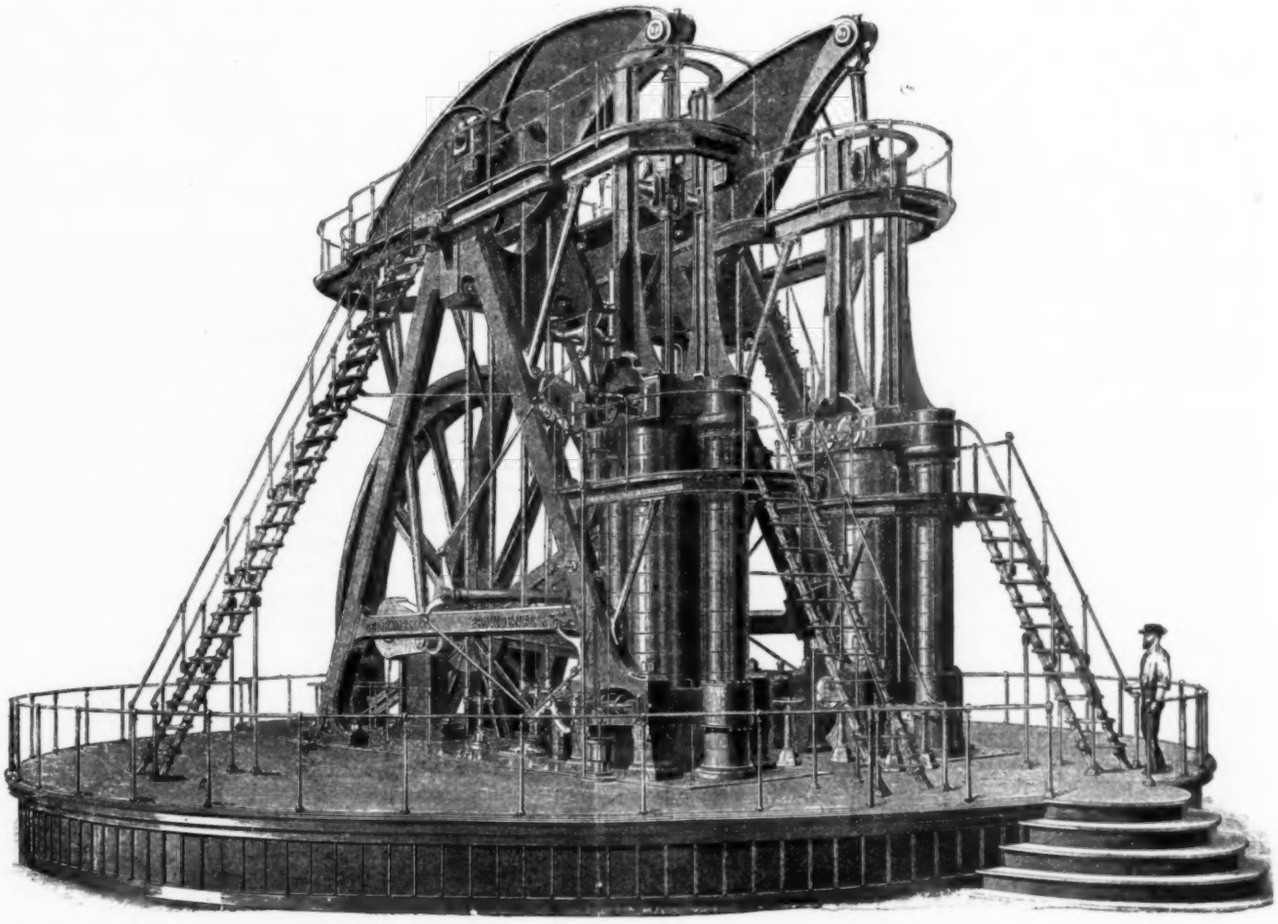
Moore saying to me before we had begun any systematic work: "Porter, if you and I had had this work to do we would have had it half done by this time." Directly after that Mr. Moore resigned, ostensibly pleading want of time to attend to it, but really disgusted at the waste of time. Our work was in a state of chaos. The field was very extensive as it embraced all exhibits pertaining to steam and water except locomotives. One morning I came to the meeting with a copy of the catalog on which I had divided the exhibits into three classes, lettered A, B, and C; class A embraced steam engines and their accessories; class B, boilers and their accessories, and class C, pumps and their accessories; I had prefixed the letters to the names of all these exhibits according to their class. At this meeting, at which I had procured the attendance of the foreign judges, this classification was unanimously adopted, and the judges formed themselves into these classes accordingly. Our work was then undertaken in earnest; it was found to be really too extensive to be accomplished otherwise.

AN IMPORTANT ACTION.

Mr. Charles E. Emery was appointed a judge to fill the vacant place made by Mr. Moore's resignation, and he proved most efficient. As is well known, medals were not awarded but brief written reports were made on those exhibits which were deemed most deserving; these reports were signed by all the judges. The firm of E. P. Allis & Co., of Milwaukee, exhibited a sawmill. This exhibit consisted of two large circular saws, each driven by a horizontal engine. The two engines were united by a common shaft on the ends of which the cranks were set at right angles with each other. The center lines of these engines were nearly 20 feet apart; the shaft carried two belt drums 8 or 10 feet in diameter, one of them near to the bed of each engine; at the middle of the shaft was a fly-wheel about 16 feet in diameter. The rim of this fly-wheel was in eight or ten segments, with an arm attached to the middle of each segment; the segments were bolted together and the arms were bolted to a hub on the shaft. The saws were set behind the cylinders, and the belts were carried from the drums on the shaft past the cylinders to smaller drums on the saw arbors. On starting these engines the two bearings of the main shaft heated so badly that the engines had to be stopped. The gentleman in charge of the exhibit applied to me for advice; I told him that although his shaft was large it was long, and the weight of the fly-wheel bent it so much that the two journals ran on the inner edges of



PORTER-ALLEN ENGINE EQUAL IN OUTPUT TO THE EXHIBITED CORLISS ENGINE.



THE CORLISS ENGINE EXHIBITED AT THE CENTENNIAL EXHIBITION.

their bottom boxes, which caused the heating. I told him he did not need the fly-wheel at all; the cranks being quartering, the momentum of the belt drums was amply sufficient to maintain uniform motion, and I advised him to take off the fly-wheel. This he did at once, leaving only the hub on the shaft; the engines then ran with cold bearings and uniform motion throughout the exhibition. They had made a cut-off gear for these engines, but it was found not to suit the purpose and was taken off. This firm then did a great stroke of business; they came to the sensible conclusion that they could do a great deal better than to attempt to work out a new system of engineering for themselves, so they offered to Mr. Edwin Reynolds, the manager of Mr. Corliss' works, and to his head draftsman inducements sufficient for them to leave Mr. Corliss' employment and take the same positions in the Allis works at Milwaukee for the manufacture of the Corliss engine there. With the magnificent result of this action the engineering world is familiar.

A PERFECT ENGINE.

We had all sorts of queer experiences. One day I was demanded by Mr. Jerome Wheelock to tell him *why* the engine exhibited by him was not a *perfect* engine. I glanced over the long slender bed, a copy of the Corliss bed without its rigidity, and declined to answer his question. Mr. Emery was more compliant; on receiving the same demand, he kindly pointed out to Mr. Wheelock one respect in which his engine could hardly be considered perfect; the steam was exhausted into a large chamber embracing the lower half of the cylinder from end to end. This comparatively cold bath produced the condensation of a large quantity of the entering steam. From the middle of this chamber a pipe took away the exhaust from the opposite ends of the cylinder alternately. Mr. Wheelock admitted the defect and said in future he would avoid it, so, as I learned, having two exhaust pipes instead ot one, he gave to each pipe one-half the area of the single one.

I had the pleasure of renewing my acquaintance with Professor Sweet, who was superintending the exhibit of the mechanical work of his boys at Cornell; this was very creditable and included quite a show of surface plates.

THE CORLISS ENGINE AT THE CENTENNIAL.

The Corliss engine in this exhibition was far the most imposing and to the multitude the most attractive single exhibit ever shown anywhere. It consisted of two distinct engines, each having a cylinder 22 inches in diameter, with 12 feet stroke of piston, the motion of which was transmitted through cast-iron walking beams to cranks set at right angles with each other on the opposite ends of a common shaft. This shaft made 30 revolutions per minute and carried a gear wheel 30 feet in diameter; this wheel engaged with a pinion 6 feet in diameter on the line of shaft under the floor, giving to this shaft a speed of 150 revolutions per minute.

One day I said to Professor Sweet: "Do you know, Professor, that an engine with a single cylinder of the same bore as these and 5 feet stroke directly connected with this line shaft and making 150 revolutions per minute, with a fly-wheel 10 or 12 feet in diameter, would exert more power than is afforded by this monster and would run with far greater economy, because the internal surfaces to be heated by the condensation of the entering steam would be one piston instead of two, two heads instead of four, and 5 feet length of exposed cylinder instead of 24 feet? He replied: "That is all very true, but how would you get the steam in and out of the cylinder properly with a piston travel of 1,500 feet per minute?" I was not prepared to answer that question on the instant, but a little reflection showed me that according to my standard proportions of cylinders, 5 feet stroke would be twice too long for a 22-inch bore and that a 28½-inch cylinder with only 3 feet stroke would have the same piston displacement; this would only require 900 feet of piston travel per minute, a speed with which I was already familiar. This would be only a medium-sized engine according to my table of sizes.

A SMALLER ENGINE OF THE SAME CAPACITY.

The accompanying engravings show the two engines drawn to the same scale; it will be seen that the small engine occupies about one-tenth of the floor space needed for the large one and I fancy about one-hundredth of the cubical space, and would cost about 10 per cent. of the money. It would also have a more nearly uniform motion, the impulses received by the crank being 300 per minute, against only 120 per minute received by both cranks of the large engine, besides which in the latter the full force of the steam was exerted at the commencement of each stroke and fell to nothing at the end, while in the smaller engine, by the inertia of the reciprocating parts, the forces exerted at the opposite ends of the stroke were equalized. The reader will doubtless inquire, as Mr. Green did, why with these enormous advantages does not everybody use the high-speed engines and every builder make them?

At this exhibition the Bell telephone was first shown to a select company, of which President Grant was one. This exhibition was given on Sunday, that being the only day when silence could be had. Human speech, both in talking and singing, was transmitted through the whole length of the main building, about 1800 feet; it has since been transmitted somewhat farther.

PUMP NOVELTIES.

The exhibitors of hand pumps all talked about the ease with which their own pumps could be worked; one man touched bottom in this respect. He had set his pump so that the spout was nearly on a level with the surface of the pool from which it drew its water; he boldly claimed that his pumps required no power at all. I was invited, as I suppose multitudes were, to take hold of the handle and see for myself that his claim was true. I never heard of but one man who I think would be satisfied with this demonstration; that was the engineering editor of the New York *Tribune*. Shortly before this he had published an account of a wonderful pump invented by a Mr. George, which he concluded by saying that the superiority of Mr. George's pump lay in the fact that at each stroke not the whole column of water had to be lifted, but only that which was to be discharged. We had a waterfall maintained by a centrifugal pump which received its water on one side only; the maker evidently knowing nothing about the method of balancing these pumps by admitting the water equally on the opposite sides.

FREAK BOILERS.

The boiler makers abounded. My old acquaintance, the Harrison boiler, turned up. Mr. Allen urged a favorable award to Mr. Harrison because of the motives of humanity by which he knew Mr. Harrison was actuated in designing that boiler. A Mr. Pierce invited all the judges to visit his boiler and hear him explain it. He informed us that this boiler had been the subject of three scientific tests by Professor Thurston, but he did not tell us the results of those tests.

As we were coming away Professor Reuleaux said to me: "That *is* foolishness, isn't it?"

An inventor named Smith came several times to our judges' room to urge upon us the merits of his boiler. He had two on exhibition, one in the boiler house and the other in Machinery Hall; these were quite different from each other. One day not long after the close of the exhibition I received a note from a stranger requesting me to call upon him at the Astor House. I thought, "The man doubtless wants an engine, but his time is too precious to come out to Newark," so at the hour appointed I was there. When I entered the room the first object I saw was a sectional model of this Smith boiler and I found that the gentleman wanted to know our reasons for overlooking that boiler. I replied to him that I had a question to which I would like an answer at his earliest convenience; we observed that the two boilers exhibited by Mr. Smith were quite different from each other and I saw that this model differed in essential details from both of them, and I would like to know which one he wished us to approve of and bade him good afternoon.

One day I happened to be in Mr. Holley's office when a man came in with a

drawing of a boiler which he wished Mr. Holley to recommend. Mr. Holley turned him over to me and he explained to me that the great novel feature of his boiler was that the feed-water was admitted by spraying it into the steam space, thus avoiding the cooling of any part of the boiler by its admission at one point; so I found one freak boiler that was not at the exhibition.

A SYNTHETIC FIRE ENGINE.

We had a fine exhibit of steam fire engines. I think every maker in this country was represented, and we had a trial of these engines lasting three or four days. The committee desired to make a thorough comparative test of their performance, but the man (a lieutenant in the navy) appointed to keep the record put down so few items that we found we had no record at all. We could only guess how he came to do this.

An exhibitor from Canada brought an engine that presented a very fine appearance; it was made up of a collection of what he believed to be the best features of every steam engine made in the United States. The experts looked his machine over and saw where he had got every one of them, but his different appropriations did not work well together; his engine broke down every day and he worked all night to be ready for the next day's trial. It afforded a good commentary on the narrow-minded laws of Canada which forbade a citizen of the United States from taking out a patent there.

ENGINES EXHIBITED.

The show of steam engines was not large and the indicator was not applied to any engines, so I had no use for the indicators I had imported from England; if I remember rightly we had only two engines from abroad, one of these sent by the Government of Brazil. This was what was called a "table" engine, in which the cylinder stands on a table in a vertical position and two connecting rods extend down from the crosshead and connect with the crank under the table; it was copied from a Scotch elementary drawing book from which I learned mechanical drawing. One of these engines had been made by Mr. Hoe to drive the press of the New York *Daily Times* when that paper was started in 1852. The other foreign engine was made by a Brussels manufacturer with the assistance of the Belgian Government. It had an American cut-off which was used by Mr. Delamater on his engines, and it had the eccentric between the main bearing and the crank, giving to the latter therefore three or four inches of unnecessary overhang; it had my condenser, which I believe was then coming into considerable use on the Continent.

The only other American engines I now recall were the Buckeye and the Brown engines, and our awards to these engines did not do them any harm; the Corliss engines were not within our jurisdiction and we were not permitted to say anything about them; Mr. Corliss was a patron of the exhibition.

EXHIBIT OF MR. SICKELS' INVENTIONS.

Mr. Frederick E. Sickels made an extensive exhibit of his various inventions, the models of which had been loaned to him for that purpose by the Patent Office. The only one of these inventions which came within our province was what is properly known as the trip cut-off, patented by him in the year 1842. This celebrated invention was an improvement on the Stevens cut-off, already in general use in steamboats on our Eastern waters. The Stevens invention was applied to equilibrium valves, rising and falling in a direction vertical to their seats. It enlarged the opening movement of the valve very greatly and in a degree increasing as the speed of the piston increased, by means of the device known as the wiper cam; but the closing motion of the valve, being the reverse of the opening movement, grew slower and slower, until the valve was gently brought to its seat. It was found then that during the closing of the port a great deal of steam blew into the cylinder through the contracting openings, with very little addition to the useful effect. Mr. Sickels conceived the idea of liberating the valve just before the opening movement was completed and letting it fall instantly to its seat, which would effect a sharp cut-off and a great economy in the consumption of steam; this action involved the difficulty that the valves would strike their seats with a violent blow, which would soon destroy both. This difficulty Mr Sickels met by the invention of the dash-pot, in which he availed himself of the incompressibility and indestructibility of water. This apparatus performed two functions: when the piston was lifted above the water it left a vacuum under it, so the pressure of the atmosphere on this piston was added to the weight of the valve and the pressure of the steam on it to accelerate its fall. This was arrested by the piston striking the surface of the water just in time to prevent the valve from striking its seat, but not soon enough to prevent the complete closure of the port. This nice point was determined by the ear. The engineer first let water out of the dash-pot gradually, until he heard the valve strike its seat faintly; then he admitted water drop by drop until the sound had died away. For this invention of the trip cut-off the judges made an award.

Our foreign judges were enthusiastic about this invention; Horatio Allen had fought Mr. Sickels during his whole business life and would never allow a Sickels cut-off to be applied in the Novelty Iron Works. For example, the directors of the Collins steamship line adopted the Sickels cut-off, but it was put on only two of their ships, the "Arctic" and the "Baltic," the engines of which were built at the Allaire works. The "Atlantic" and "Pacific," which were engined at the Novelty Works, did not have it, Mr. Allen absolutely refusing to allow it. To my surprise Mr. Allen signed this award with a cordial expression of admiration of Mr. Sickels' genius; he had softened in his old age.

CORLISS, CHAIRMAN OF THE "COMMITTEE OF REVISION."

After our work was finished and I had gone home the awards were made public; to my astonishment the award to Mr. Sickels was not among them, so I wrote to General Walker, who was our medium of communication with the Commission, asking the reason for this omission. He replied that the award had been thrown out by the Committee of Revision. "Committee of Revision!" I had never heard of such a thing. I asked for an explanation and I learned that the judges did not make awards, they only recommended them; the awards were made by the Commission after they had passed the scrutiny of the Committee of Revision. Well, who were the Committee of Revision? I learned that the Commission consisted of two commissioners from each State appointed by the Governor; Mr. Corliss was a commissioner from Rhode Island. At a meeting of the commissioners Mr. Corliss proposed the novel scheme of a Committee of Revision, to which the action of the judges should be submitted for approval before the awards were made. The idea seemed to please the members of the Commission, as tending to magnify their own importance, and it was adopted; as a matter of usual courtesy Mr. Corliss was made chairman of the committee, and the committee threw out the award to Mr. Sickels. I made careful inquiry and could never learn that the Committee of Revision threw out any other award, so that it seemed evident that with the throwing out of this award to Mr. Sickels the object of its existence was accomplished.

In the Corliss valve system the liberation of the valve was the fundamental idea; this was applied to valves moving in the direction parallel with their seats. It not being necessary to arrest their motion at any precise point, they were caught by the air cushions at any points after they had covered their ports. Mr. Corliss had appropriated the liberating idea, according to "the good old rule, the simple plan, that they may take who have the power, and they may keep who can," and all this machinery had been devised by him to prevent the historical fact that the liberating idea had been previously patented by Mr. Sickels from appearing in the records of the exhibition. By all this enormous expenditure of ingenuity and influence he succeeded in giving to this fact a prominence and importance which it would

never otherwise have had, besides advertising his efforts to suppress it.

A VALVE MECHANISM THAT FAILED.

Mr. Allen's life-long aversion to Mr. Sickels was caused by professional jealousy; Mr. Allen conceived himself to be an inventor, and for years had been cherishing a cut-off invention of his own. The original firm was Stillman, Allen & Co., and for years Mr. Stillman had prevented the Novelty Iron Works from being sacrificed to Mr. Allen's genius, but later Mr. Allen had obtained supreme control of these works by an affiliation with Brown Brothers, the bankers, his principal stockholders, and Mr. Stillman sold out his interest and retired from the firm. Mr. Allen, having a clear field, now determined to put his invention on the new steamer of the Collins line, the "Adriatic," and American engineers were amused at the display of this amazing absurdity on the largest possible scale. In this construction there were four valves; each valve was a conical plug about six feet long and had four movements: first it was withdrawn from its seat a distance of three inches so that it could be rotated freely, then it was rotated first to draw off the lap. Up to this point theoretically the port had not been opened, but the steam had been blowing into the cylinder, or out of it, as the case might be, through these enormous cracks; the valves then rotated further to produce the opening movement, for either admission or release; the rotation was then reversed until it reached its original position, then the fourth movement brought it to its seat. It is probable that the ship would have gone to sea working steam after this ridiculous fashion, if the complicated mechanism required to produce the four movements had not broken down at the trial of the engines at the docks, beyond the power of Mr. Allen's genius to remedy; so the valves and to be removed and the Stevens valves and cut-off were substituted for them. These engines, as further designed by Mr. Allen, were afterward described by Zerah Colburn in the London *Engineer* in his usual caustic style. His description began with this expression: "These engines are fearfully and wonderfully made."

J. W. Woermann, assistant engineer in the service of the United States, has obtained economical results in the reduction of maps by photography, reducing maps on a scale of 1 inch = 400 feet, and 43 inches wide, 6, 10 and 12 feet long, down to a scale of 1½ inches = 1 mile. They were photographed on 5x8-inch Cramer's contrast plates, and printed on Eastman's Solio paper, and then the lines were transferred to drawing paper by the use of graphite impression paper and a stylus. It was possible to photograph a map 12 feet long on two 5x8-inch plates; however, three plates were used so as to eliminate any chance of distortion at the ends.

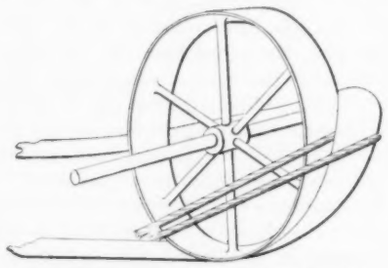
Letters to the Editor.

Shop Accidents—Looking After Belts.

In an editorial at page 34 on "Shop Accidents," you appear to be under the impression that many of these accidents happen to millwrights, who habitually put on belts "on the fly." My experience would seem to prove that you are in error in this particular, as, instead of forming the rule, they are rather the exception.

For eleven years I have been master mechanic in textile finishing plants, where much of the machinery is heavy, and in certain departments, owing to the steam used in process boiling, the atmosphere is clouded with masses of vapor which condenses on the pulleys, making a great deal of trouble with the belts.

The question of shutting down to put a belt on is entirely a matter of judgment with the master mechanic, although it is obvious that in a plant where, during the early morning hours of each winter day, the belts off will average one every 15



PUTTING A BELT ON A RUNNING PULLEY.

minutes, he will of necessity have to avoid stopping as much as possible if he desires any production at all.

In some of the more recent electrically driven plants, where each room has its motor, the objection is overcome to a large extent; but to shut down the main engine, place and rope the belt on the pulley, and then start slowly to get the belt on and the rope off, before allowing the engineer to come up to speed, will use up from seven to ten minutes' time, work as quick as you will, and under the conditions outlined this would never do, particularly if the master mechanic has any regard for either his reputation or position. I have spent many long hours on this problem, but have never yet been fortunate enough to have a plant where the solution was other than throwing on the belts while running. If the rooms could be held at such a temperature that the vapors would not condense, or where the escaping steam would not form so dense a vapor, belt troubles from that cause would end; but this would mean a large expense for heating, too large to be considered. Moreover, in the middle of the day a dye house, for instance, gets so hot from the necessary processes as to require large ventilators and exhaust fans to make it suitable for men to work in; so it is plainly seen that to keep the proper temperature during the first four morning hours would necessitate arranging the exhaust fans so they could be stopped at will, the application of special large ventilators that could be easily closed, and the installation of a heating system to run part of the night and part of the morning. This arrangement is for one particular department, and every department where steam is used open to the atmosphere would have to be given its special study and treatment.

I have merely given the above data to show that, to a certain extent, the throwing on of belts while running is a necessary evil and should be met as such.

In the plants where my experience was gained, the belts giving trouble were from four to ten inches wide, the greater number being eight and ten inches. The shafting in the different departments varied as to speed from 190 to 228 revolutions per minute, and the pulleys varied with the nature of the machines, from 12 inches to 42 inches in diameter.

In some places I had the carpenters build wooden guides on each side of the belt close to the pulleys, to prevent the belt coming off at all; and while these wore the edge of the belt to some extent, that was a lesser evil and was allowed. This could not be done on all belts, however, as it was very necessary to be able to throw them off quickly in case of an accident in the machines, which sometimes occurred.

I always employed a "belt man" whose duty it was to inspect all belts and repair or take up these at noon or at night, when possible. This belt man was carefully selected according to the requirements of the job, which called for a man who would be on duty *every day;* who did not object to working some nights for extra money; who had a cool head and a strong arm; and who had the ability to apply the best means to attain the desired end and do it without being told. I made the job a rather desirable one by adding no "filling in" work, so that after four hours of hard work in the morning, the belt man would be on "easy street" the rest of the day, as the care of the belts from ordinary breakage was light. He had the privilege, also, of calling to his aid certain men in the shop without consulting anyone.

I have never gone so far as to try unwinding a belt from a moving shaft, as such a performance is foolish to the last degree, inasmuch as it is a comparatively rare occurrence to have belts so wind up.

I had stout poles prepared with spurs in the end and a finger fastened on the side, and where the belt came on at the top of the pulley, it could generally be thrown on from the floor by two men with these poles, one holding the belt up on the face of the pulley and the other catching the edge with the pole finger and pulling it on. This operation required "knack" and a strong arm at the psychological moment. Where the belts run on from the

other side of the pulley, or in the cases of specially tight belts, the better plan is to take a piece of common bale rope up on the ladder, slipping it around the belt and bringing the two ends even as in the sketch. Steady the belt with one hand while the man on the floor pushes it up onto the pulley with one of the poles, then with the other hand pass the two ends of the rope twice around the shaft close to the hub of the pulley and in the direction of the rotation. Be careful and keep clear of set screws by keeping just a little tension on the rope. Step down a step or two on the ladder and grasping the ends of the rope in one hand, give the man on the floor a signal for a concerted effort, and with a pull the belt is on and the rope may be removed if it has not already removed itself. *Under no circumstances should the rope be wrapped around the hand;* be content to merely grasp it firmly. If it catches on the side of the belt, you won't have to be told to let go. This sounds like a dangerous operation, but I have had it in practice for over ten years and have never yet seen it cause a "wind up." Two essential points in the game are clean shafting and a cool head. I have never had a man in my employ more seriously injured in throwing belts than to receive slight burns from rubbing against the rims of moving pulleys.

As I said in the beginning, the master mechanic must use his judgment and not allow the roping of belts at particularly congested points on his shafting. I have seen one serious belt accident, but it was a case of a green machine hand trying to do the belt man's work, and after that I had every department foreman make it a compulsory rule that all belts four inches or larger should be referred to the belt man.

When throwing on a belt, if the pulley or belt is wet, wipe both fairly dry before attempting to throw the belt. If the belt is of rubber, with the rubber partly worn off, get it back on the pulleys as soon as possible, as if wet it will draw up several inches in a short time.

Use good belt dressing but use very little at a time. Never depend on lace leather where the belt runs in wet, steamy places; it will "fall down."

If belt hooks are used in wet or steamy places, or where acidulous vapors get in contact with them, renew them every two weeks. This may seem rather frequent, but they don't cost much and a shut down does.

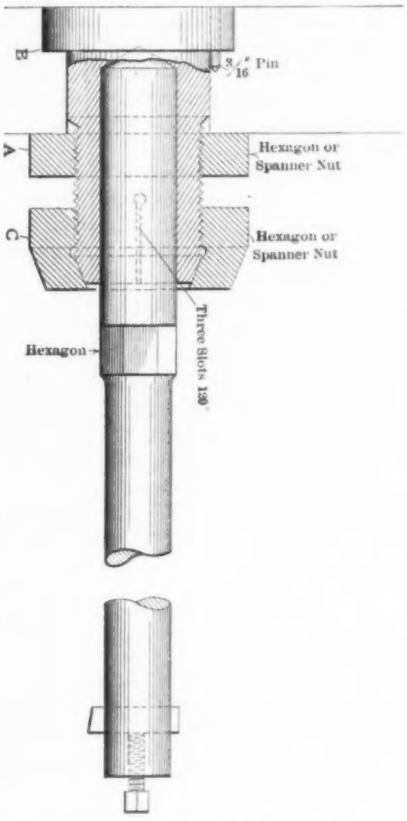
Never put on a new leather belt in a steamy room without pegging the laps. The cement may be of the water-proof variety, but if it does give way, which is more than likely, it will be certain to do so when goods are in process that will be spoiled by stopping.

There is one more point to consider in this stopping for belts question, that applies to dye houses directly. If the stop is made with goods in the machine, there will be spoiled approximately ten yards of cloth for each single box machine. If the runs are finished before stopping, it means 15 to 20 minutes' delay in getting the belt on and those depending on it have to sit around and wait.

New Britain, Conn. L. L. ARNOLD.

A Keyseating Tool for the Shaper.

The sketch herewith needs little explanation. The tool is used in the shaper or planer for keyseating pulleys or gears. It is made to fit the clapper block of the shaper and the only change or work on the machine is the drilling of one 3/16 hole for the pin shown. It is sometimes



KEYSEATING TOOL FOR THE SHAPER.

necessary to have a washer under the nut *A*, where the head is roughened. The chuck *B* is made of machinery steel, case hardened, and the nuts and bar of tool steel. The hexagon on the bar serves two purposes; one for setting the bar, and second, where it is desired to plane a semicircle it may be turned with a wrench. To plane a semicircle the nut *C* is made just tight enough to hold the bar steady while it is rotated. It often happens in a shop that a piece larger than can be bored on the lathe can be planed in this way.

HERMAN JONSON.

Roll Grinding.

Referring to the discussion between Mr. Norton, at page 840, Part 1, and Mr. Hollinger, at page 712, on the respective merits of grinding rolls, in the one case on centers, and in the other in suitable supports at the necks, it seems to me there are strong points in each argument which can be readily brought together; or that each is right and the other not necessarily wrong.

Mr. Norton's arguments on the advantage and necessity of having large and true centers are not to be controverted. When, however, he says that the large centers do away with the necessity for, or advantage of, supports for the neck of the roll, I cannot agree with him.

These supports or roll-carrying bearings have two distinct advantages: First, they decrease the distance between the supports, or rather the unsupported length of the roll, which is an advantage in all cases; else why do we use back rests on large work as Mr. Norton advised in his "Points on Grinding?" Of course with a roll short and of large diameter this advantage would not be so apparent, but the majority of rolls are of sufficient length to make this point worthy of notice. And second, the chief reason for these supports is that they take the thrust of the centers off the head and foot stock. This thrust is no inconsiderable amount if the work is heavy; and if the work is long enough to bring the head and the foot stock well out toward the ends of the swivel table, and the latter overhangs the bed at the ends of its travel, its ability to withstand this strain is lessened.

I believe that if the large centers be used for grinding the necks of rolls, and a substantial support for the necks when grinding the bodies, the best results will be obtained. The only real disadvantage in the use of roll-carrying bearings for the necks is the additional power required to drive the rolls, and that is a small item compared with the greater accuracy obtainable. H. F. NOYES.

A Boy's Objections to Serving an Apprenticeship.

Reading Pessimist's article on the apprentice system at page 25 moves me to say a few words. I have been at the trade about seven years and have had a good deal of experience with the apprentice systems of different shops, and with some shops that have no system at all; and I know that in the majority of places the apprentice boy can only hope to become a specialist. "Serving time" does not mean what it did twenty years ago. Of course, the changes in the business are responsible for this, and whether for better or worse it is the way the world is moving and cannot be helped.

Still I do not think it is all so dark as Pessimist paints it. I think it is possible for a boy to become an all-around man today, if he has natural talent and lots of grit.

I have had a good all-around experience, and the way I obtained it was to change from one shop to another when I wanted

different work. I have worked in eight different shops. The small job shop is a good place to learn, though the machinery is not apt to be as good and up to date as in the large manufacturing shop, but in the latter it is impossible to get anything but one class of work, except in the tool room; and in the larger places that is specialized too. I worked in one shop two years and in spite of the fact that my work was all on the planer and miller the time was not thrown away by any means.

Education counts much more today than it did some years ago, but there are the night school, the correspondence courses, and technical colleges with short practical courses.

As to the associations of the shop, I do not think they are any worse than in other trades and even professions. Machinists may be a little rough in words and manners, but at heart (and that is what really counts) they will compare favorably with most of mankind. If a boy has not strength of character enough to stand the shop associations he will not amount to much anywhere. If I had it to do over again I would enter the shop the same as I did. OPTIMIST.

Planetary Gears.

At page 830, Vol. 29, Part 1, you publish an article on Planetary Gears, by Andrew Strom, which, while the examples of this peculiar style of mechanism given are good, calls for a few remarks regarding some of the statements made, which must not be taken too literally.

In the first paragraph, Mr. Strom states that this style of gearing has not received its proper share of attention in works on mechanism. I think he is mistaken on this point, as he will find it hard to name any book on the subject of applied mechanism which does not give considerable space to the planetary system of gearing. I do not wish to be understood as being in favor of the manner of presentation in these works, but think the method of positive and negative rotation of the mechanism, as a whole and then in detail, the most satisfactory method of analysis. This method I will take up in describing the examples I wish to show later on.

I do agree with Mr. Strom that draftsmen and machinists, as a class, have but hazy notions of this kind of gearing, but I would not favor its general adoption, as it has some features which do not work well in practice.

I cannot bring myself to believe that internal gears can be produced as cheaply as are spur gears, and few machines for cutting gears are furnished with internal-gear cutting attachments. Furthermore, the feed and stiffness cannot be obtained through the use of auxiliary attachments that can be obtained from the unadorned machine. These are all features against the internal gear.

Mr. Strom also shows that a reduction of 2 to 1 cannot be obtained with planetary gears *of the design he gives.* To those who are not well advised this statement may be taken too broadly, and be mistaken to mean that a 2 to 1 reduction cannot be obtained with any design of planetary gears.

To show that a reduction of 2 to 1 is possible I submit the example of Fig. 1 which shows a cone with differential back gears in connection. This arrangement is the simplest type of planetary gears, and is somewhat similar to Watts' original design. The cone is free on the shaft to which is keyed the sliding-clutch and the gear *A*. Within the large step of the cone is a head pinned to the rim, so that they revolve as one. This head has three bearings, one of which fits the shaft, while the other two fit studs which carry and transmit the motion from gears *B* to *C*. Gear *D* is free on the shaft, and in the bearing *E* transmits the motion to the driven-gear *F*, which is keyed to the outer end of the hub of gear *D*. The action is as follows: When the cone is to run open belt, the sliding clutch is engaged with the clutch on the cone hub, locking the shaft, cone and gears so that they act as one and transmit the motion direct to the driven gear and whatever follows. Throwing the sliding clutch in the mesh with the fixed clutch frees the cone and locks the shaft and gear *A* which is keyed to it in a stationary position. When the cone revolves it carries along with it the two outer bearings with their corresponding gears, causing them to revolve round their centers and that of the gears *A* and *D*. Let us use the method of analysis mentioned above, and examine the motion of all the members of this mechanism as a whole and independently. In what follows, motion in the direction of the hands of the clock will be called positive, and that opposite negative. With the mechanism locked as described above, one turn in a positive direction would move each member once about its axis; we will record this motion as shown in the first line of the table.

	Cone	A	B	C	D
Locked,	+1	+1	+1	+1	+1
Unlocked,	0	−1	+1	+1	−½
	+1	0	+2	+2	+½

Unlocking the mechanism and placing the sliding clutch in a central position, and holding the cone in the position it now holds, we revolve the shaft and gear *A* one revolution in a negative direction, and obtain the relative motions of the several members as recorded in the second line of the table. Summing up the results we have the statement that one revolution of the cone in a positive direction with the shaft and gear *A* locked in a stationary position, causes one-half of a revolution of the driven gear *D* and two revolutions of the intermediate gears.

Fig. 2 shows another example of planetary gears. This style is suitable for use where great reductions in speed are desired. The case shown has a speed reduction of 40 to 1, and is the simplest method of obtaining such a reduction without the use of a worm and gear. This arrangement is similar to that used in the Brainard automatic gear-cutting machine in obtaining the great ratio of feed to the return of the cutter carriage. The mechanism consists of a cone, a fixed gear, a revolving gear, a planet gear and shaft. The cone is free on the shaft, the fixed gear is fastened to the frame of the machine, the revolving gear is keyed to the shaft which it revolves. The planet gear is carried on a stud screwed into the cone which carries it around the fixed and revolving gears. These gears differ by one tooth; in the case on hand the fixed gear has 39 teeth and the revolving gear 40. The planet gear is made to mesh with

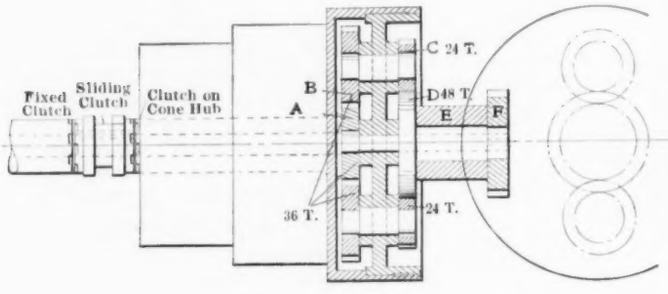


FIG. 1.

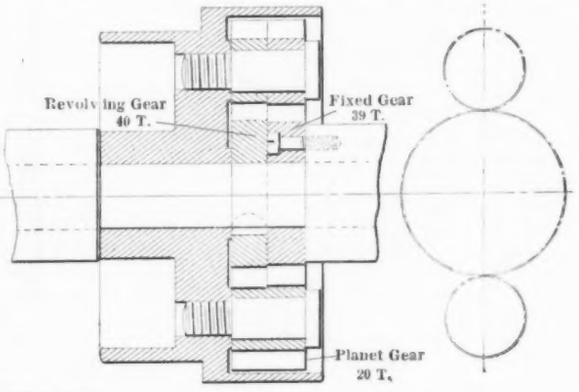


FIG. 2.

EXAMPLES OF PLANETARY GEARS.

both gears by cutting that portion which engages the larger a trifle deeper, causing a decrease in the pitch-line diameter. Opposite the planet is located on a single stud two idle gears to counterbalance the planet gear. The rolling of the planet gear around the central gears causes the revolving gear to advance one tooth for each revolution of the cone.

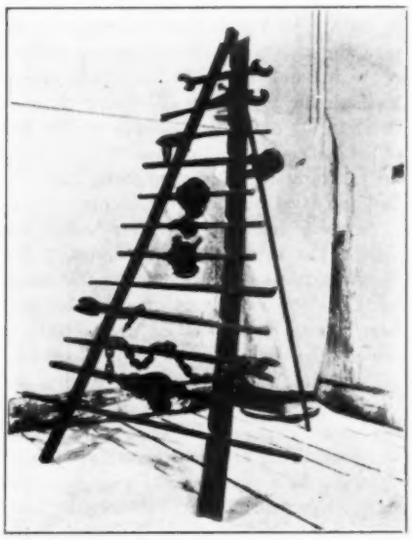
This mechanism is but a modification of the one given in Fig. 1, but shows to what extremes we may go in procuring very great ratios with the least amount of detail.

The above is not given as a criticism, but to show some interesting examples of a different design from those given by Mr. Strom, and to call attention to the statements which may be taken in too broad a sense.

JOHN EDGAR.

"A File Rack"—A Metal Rack for Pipe Tongs, etc.

At page 779, Part 1, "Bell Crank" describes a file rack in the shape of the



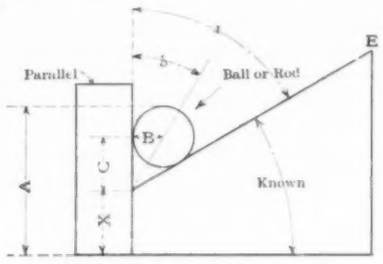
RACK FOR PIPE WRENCHES, ETC.

letter A with the files resting on wood pins. I made a rack on this principle several years ago to hold such tools as die stocks, pipe tongs, wrenches, crowbars and anything that we wanted kept out of the way, and yet convenient when needed in a hurry. The photo shows it in use. It is made of two pieces of angle iron 2x3x3/8 inch, seven feet long. A rear support of the same length made of round iron or pipe is hinged between the angles at the top by a bolt passing through the three members; this forms a tripod and by changing the position of the hinged support any desired angle may be given the face of the rack. The tools are supported in angular slots cut in the vertical legs of the angles. The capacity of this rack might be increased three-fold by discarding the single support at the rear and substituting two angles, forming a square pyramid composed of four angles. The slots in opposite faces would then be in the same plane and alternate with the other two allowing tools to project without interfering with each other.

J. J. NEWBAKER.

Measuring Angular Pieces.

This sketch shows an accurate but simple method of measuring angular pieces. For ordinary work the process would not be necessary, but for gage work in which it is necessary that the piece be ground and



MEASURING AN ANGULAR PIECE.

lapped to a certain size this method will, perhaps, be as good as any.

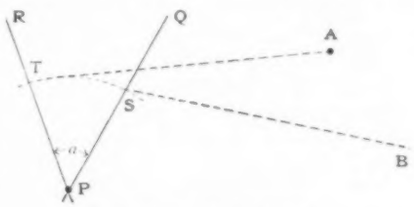
As will be seen, a parallel is clamped against the piece, or the piece and parallel can be held together, with the hand, and a steel ball, rod or plug gage of known diameter is placed within the angle formed. The distance A can readily be measured, and as the center line of the inserted piece bisects the angle a we can calculate the remaining dimensions by trigonometry.

$C = B \cot b$ $\qquad A - (C + B) = X$

C. E. J.

A Geometrical Problem.

Inclosed is a geometrical problem which I submit to your readers for a solution. A rock arm centered at P is required to be driven from position PQ to PR, through a given angle α. The driving stud has the two given positions AB as the limits of its travel, these points being chosen in any arbitrary way. The



A GEOMETRICAL PROBLEM.

problem is to find the point T on the driven arm and the length AT of the connecting link, by exact construction, not by trial, so that the driven arm may receive the required angular motion.

E. H. LOCKWOOD.

The Government has established a timber-testing station at the University of Washington, Seattle. Western hemlock will be tested there.

Experimental Technology of Deformation of Materials, and Its Application to Metal-Working Processes—I.

BY H. I. HANNOVER.*

INTRODUCTION.

The mechanical technology has in the past century been extensively enlarged, not only by virtue of the many new machines and working methods that have been invented, but also by adopting a quite new branch, *the experimental technology*, as the founder of which may be named Professor Tresca, at the "Conservatoire des Arts et Métiers." Formerly the technologists had mostly contented themselves in *describing* the working of the metals and of other materials; for instance, they described how to forge, without examining the process in an experimental way, as for instance the movement of the molecules in a piece of iron when being extended by forging. Investigations were highly needed, especially concerning *the deformation of tough bodies;* and, indeed, Tresca devoted himself particularly to that study and proved that such deformations completely corresponded with the outflowing of liquid bodies, only with the difference of degree that solid bodies require the development of a more powerful force for yielding as if in the liquid state. He stated that, while water runs out through a hole in the bottom of a receptacle simply by its own weight, a strong pressure is required to get lead to run in a shoot from the same receptacle; but in the processes, the forms of the shoot, etc., there was a close correspondence between the outflowing of the lead and that of the water. A large number of investigators have since followed in the footsteps of Mr. Tresca, and in the following a general view will be given of what at this moment is known about the processes of deformation in tough bodies, especially tough metals, by compression, tension, impact, etc. Here and there some remarks will be interwoven about the conditions of brittle bodies when bursting.

SECTION I—EXPERIMENTS ON DEFORMATION BY COMPRESSION, AND THEIR PRACTICAL APPLICATION.

A. EXPERIMENTS AND THEORY.

About the deformation by the displacing of molecules caused by pressure the Austrian professor, Kick, has set forth the following views:

When a cylindrical body, the single molecules of which are supposed to be spherical, and are represented by the small circles, Fig. 1, is pressed between two pressure plates, AB and CD, and we suppose that every single molecule in the upper layer is perpendicularly pressed down

*Professor in the Royal Polytechnic Institute of Copenhagen; Director of the Danish Government Testing Laboratory.

to the same extent, then there must be formed two conical frustums, or, when the cylinder is sufficiently high, two cones, the tops of which are pressed together, the molecules inside them receiving symmetrical oblique pressures and consequently moving vertically, while on the contrary molecules which are located outside these cones (and which are hatched on the figure), are pressed obliquely or horizontally sidewards.

The above-mentioned cones or conical frustums which are moved perpendicularly, one against another, are called *sliding-cones*. In the case that the bodies have a parallelepipedal form, we have *sliding-pyramids* instead of sliding-cones.

Nevertheless, in Mr. Kick's views there are two deficiencies—firstly, that the cohesion between the molecules is not taken into consideration; secondly, that the molecules are presumed to be spherical, and arranged in a manner in which they can not possibly be simultaneously placed when we consider a vertical section at right angles to the plane of the paper. Thus the supposed arrangement can scarcely be correct, while there is no reason for supposing that the arrangement should be in such a degree different in two different directions of the body. Indeed, a point as *M* in the Fig. 2 inside the upper sliding-cone is, no doubt, influenced by a force downward obliquely to the right and not perpendicularly down as supposed by Mr. Kick. The pressures upon the range *g h* from the upper pressure plate must undoubtedly push *M* directly down, while the pressures upon *f g* must push *M* in an oblique direction down to the right. Meanwhile we shall see that Mr. Kick's explanation nevertheless must approach to the real and true relations, because if the body is soft, slidings often arise in it in symmetrically oblique directions, without cessation of the cohesion; and if the body is brittle, it often crashes in such way that the sliding-cones remain, while the rest of the body falls in fragments to the sides. Although Mr. Kick's explanation cannot be correct, the reason why the process nevertheless practically approaches to what might be expected in accordance with it must be, it is supposed, that when two points as *M* and *N*, as explained above, should be influenced obliquely outward, each to one side, they nevertheless remain together by force of *cohesion* (which Mr. Kick has not taken into consideration) in a perpendicular downward direction, as far as points inside the limits of the sliding-cones are concerned.

THE "ANGLE OF ACTION."

When at a compression test on a brittle body particles of it, as mentioned, fall out to the sides, two sliding-cones remaining, it results that the angle β, Fig. 2, the so-called *angle of action* which the generatrices of the cones form with the pressure-plates, *varies for the different materials* from something more than 50 degrees up to 61 degrees, and is consequently near to the 60-degree angle which the arrangement in Fig. 1 would give, but which is *constant for the same material*. In analogy herewith, the normal appearance of a crushed cement tube shows two pyramidal frustums (sliding-pyramids) which remain on each other, Fig. 3.

Further, when the form of the pressed body is parallelepipedal, and when the parts, as for instance *a* Fig. 4, yields more the four sides, are of a different resisting power, it may happen that one of these parts, as for instance *a* Fig. 4, yields more readily than the others; in that case the fracture is effected by a sliding along the plane *m n*. That will, for instance, be the case, when the piece *b* by special circumstances is prevented from sliding aside. We shall presently show that this, as a rule, takes place on using cutting tools, as for instance, when a planing tool takes a chip in a planer. Of course, a *calculation** may be made in order to determine the angle under which the fracture *m n* of a brittle body may go on, and the slidings may take place at the yield point of a tough body for a minimal pressure between the pressure plates, and it is here supposed that the sliding, which in the brittle body will lead to fracture, is counteracted partly by a tangentially acting cohesion in the material, partly by the friction. But this calculation has scarcely any great value, because we do not even know whether, upon the whole, a friction is possible before the said cohesion has been overcome. However, when this is supposed to be the case, the co-efficient of friction can at most be 1, and in that case we find the value β for the angle of action $= 67\frac{1}{2}$ degrees; while, on the other hand, regarding this supposition as not being valid, or, in other words, the co-efficient of friction as being equal to 0, gives $\beta = 45$ degrees; if the co-efficient is $\frac{1}{2}$, we get $\beta = 58\frac{1}{3}$ degrees, consequently nearly equal to the values for the angle of action which are found by experiments.

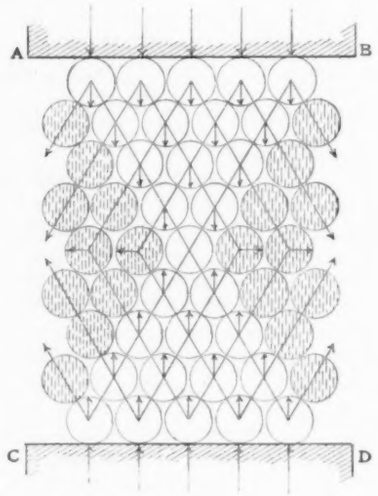


FIG. 1. DIAGRAM OF THE MOLECULES OF A BODY IN COMPRESSION.

When a narrow iron piece *J*, Fig. 5, is placed upon a stone cube lying on a pressure plate, and when we, by means of that iron piece, act on the stone, the stone wedge that is pressed down into the rest of the material by the iron piece, will be inclined to give a fracture partly along its lateral superficies, partly farther down along a single plane through the stone from the edge of the wedge, as shown by the full line in the figure; for the little wedge penetrates the stone much more violently than the dotted pyramid penetrates upward into it, so that the former splits the stone in its whole extent.

THE CRUSHING OF STEEL BALLS.

If we crush a hardened steel ball between two other balls of the same kind, as shown in Fig. 6, small planes will, before the crushing takes place, be pressed upon it, and then the crushing ensues through the formation of sliding-cones in the interior of the ball, based on the flattened parts of it, and these cones, when approaching to each other, will split the ball into two or more fragments.

A few years ago, Professor Stribeck in Berlin, has shown by experiments* that the breaking stresses stated by the manufactories for steel balls intended for ball-bearings, often are taken from tests in which the balls are crushed between plates, into which they had, during the test, been pressed down, so that the breaking stress has been found much larger, than when the test had been executed by crushing between balls, as shown in Fig. 6, and has depended more upon the hardness of the plates than on that of the balls. The same has been found by American tests.† Further he showed that, crushing a ball between two others, it will be crushed when the load is alternately applied and released, by about ¾ of the force necessary for crushing between balls when the load is applied steadily; in the case of alternate applying and releasing the fracture occurs during the relaxation of the load; and finally that, by a subsequent exact examination (sometimes even a microscopical examination is needed) of the flattened point of the balls after a previous etching of that point, we may happen to meet with cases where a circular fracture-line appears, even if the load employed has been only a little fraction—sometimes even less than 1/10—of the normal fracture-load for bursting by pressure

*Originally published by Mr. Kick in his dissertation in Dingler's *Polytechnical Journal*, 1877, vol. 224, p. 470—or possibly by Mr. Navier; the same calculation has also later been indicated by Mr. Durand-Claye. Among the calculations which concerning this matter have been set forth by others, that of Mr. Mohr, *Zeitschrift des Vereins deutscher Ingenieure*, 1900, pp. 1524 and 1572, merits particularly to be quoted: in a quite different way he arrives at a similar result as Mr. Kick.

*Executed in the "Centralstelle für wissenschaftlich-technische Untersuchungen" and described in the *Zeitschrift des Vereins deutsch. Ing.*, 1901, p. 332.

†Baumaterialienkunde, 1900, p. 128.

between balls. This occurrence is of great importance when ball-sockets are in question, since we may expect that fragments will separate themselves from the balls by a far less pressure than the normal fracture-load; this is most likely due to the above mentioned circumstance. When, during the flattening, such circular fracture-lines arise gradually and concentrically, and when at last a perpendicular splitting of the ball takes place, we might suppose that the pressure against the flats still keeps the different parts together, so that they break up only either when the pressure increases, or when on the contrary the load lessens, thus allowing the flats to become straight again. It is worth noticing that no formation of sliding cones is observed during the relaxation, whereas in such case the fracture takes place quite diametrally.

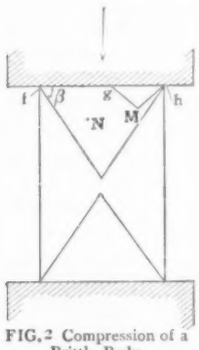


FIG. 2 Compression of a Brittle Body

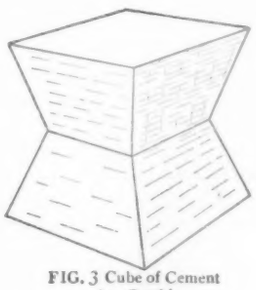


FIG. 3 Cube of Cement after Crushing

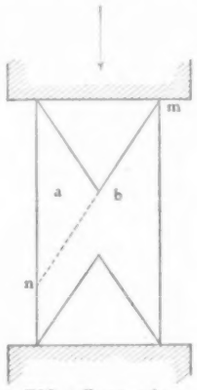


FIG. 4 Compression

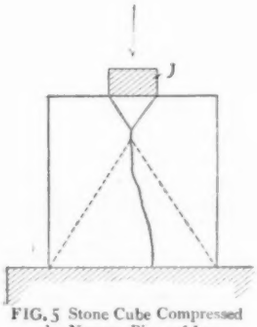


FIG. 5 Stone Cube Compressed by Narrow Piece of Iron

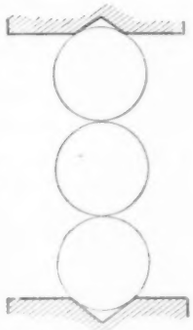


FIG. 6 Steel Ball pressed between Balls

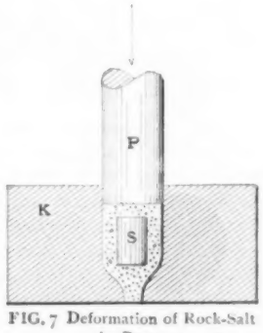


FIG. 7 Deformation of Rock-Salt by Pressure

OBLIQUE AND STRAIGHT SYSTEMS OF FRACTURE.

As for the small, elastic flats which appear on the balls in the just-mentioned case (Fig. 6) as well as for such other deformations to which metals may be subjected, we here only beg to remark, that while they of course are very important for the technical mechanics with all its calculations depending thereon, they are without any direct interest for that section of the technology which treats on the work of form-giving, and which considers only the visible permanent deformations which take place when the yield point has been passed. As brittle bodies have no yield point, their relations to exterior forces which act upon them for deformation are without interest for the section of the technology referred to, but are of interest for the section which treats of the partition of metal pieces, as these relations determine the direction of the fracture. In reference hereto we have seen that these pieces, when exposed to a sufficiently great pressure, as a rule burst in directions which form oblique angles with the direction of the force, or, as it is said, burst according to the oblique system. However, we meet also with cases where the fracture, owing to a pressure, takes place according to the straight system, i.e., parallel with the direction of the force, and where, consequently, a crushing between horizontal pressure plates only causes one or more perpendicular cracks; these cases seem especially to occur with very brittle bodies. So it is indicated that glass cubes, owing to such a pressure, are split into perpendicular needles;* the reason herefor must be, that parts of the cube striving to yield to the sides, there arise horizontal stresses, which, almost without deforming the body break it to pieces in perpendicular and not in oblique planes. Mentioning some tests made by Professor Föppl in Münich concerning the crushing of cubes of cement, sandstones and granite, we will later return to this matter.

*See "Baumaterialienkunde," 1901, p. 286.

TOUGH AND PLASTIC MATERIALS.

While we hitherto have chiefly treated the relations of brittle bodies to compressive stresses, we will now examine the corresponding relations of tough and plastic bodies, i.e., such bodies as can endure a visible, permanent deformation before a fracture takes place in them; or, in other terms, which can yield.

However, we may at first call attention to the fact that the difference between the two species of bodies is only a relative one, the brittle bodies becoming plastic when they are inclosed on all sides by a sufficiently great pressure. In that case they can, without bursting, endure a changing shape, as for instance when the inclosing cover undergoes a deformation. So Mr. Kick has deformed a marble ball by inclosing it in a strong cover of copper or brass and filling up the gap between the ball and the cover with melted alum, and then exposing the cover to a pressure. Afterward the alum was disssolved in water. Moreover, Mr. Kick has incorporated a bar of rock-salt into melted shellac in a short piece of gas-pipe which was shut at the end; after cooling he has bent the pipe and afterward removed the shellac by dissolving it with spirit, and in that way he has obtained a bent bar of rock-salt. Among the many other experiments made by Mr. Kick we may note that he has been able to coin marble, meerschaum, amber, etc.,* under a high pressure of surrounding fluids, and that, by pressing a steel piston *P*, Fig. 7, against a mass of stearin into which a cylinder of rock-salt *S* was incorporated, so that firstly stearin powder and later rock-salt-powder fell out of the bottom hole of the steel block *K*, and by then interrupting the experiment, he has succeeded in retaining a deformed piece of rock-salt in the bottom hole and the higher conical part of the hole, after having melted away the stearin. The pressure of 36 atmospheres is sufficient for making rock-salt plastic.

Finally we will here only note that the experiments made by Mr. Kick have confirmed the previous assertion of Professor Heim at Zürich (1878), viz., that many rocks which are now brittle, undoubtedly owing to high pressure, to which they were exposed during the formation of the mountains, have been formerly in a plastic state.

Concerning the relation of tough and plastic bodies to pressing action, a lead cylinder will, when pressed, swell out to the form of a barrel as a consequence of the relations described in the beginning with reference to Fig. 1, no fracture along the sliding-cones taking place almost immediately as in the case of the brittle bodies.

Fig. 8, which represents a compressed

*The experiments of Mr. Kick are, for instance, described in his "Das Gesetz der proportionalen Widerstaende," 1885, p. 76, and in his "Technologie," 1898, p. 46. Later experiments about the subject made by the Professors Adams and Nicolson, under enormous pressures, are mentioned in the "Baumaterialienkunde," 1901, p. 56.

lead cylinder, which had been in the beginning divided on its curved exterior surface into 8 equally high parts, illustrates the fact that the top and the bottom layers must have been most compressed by the pressure. We shall later come back to the aspect of the compressed cylinder, where the so-called Lüder's lines sometimes appear on the surface.

When a copper cylinder is exposed to a pressure it will, of course, take the form of a barrel quite as did the lead cylinder, but when a lead disk is placed beneath it and another above it, as in Fig. 9, the copper cylinder and the lead disks, as shown by Professor Kick, will take the form shown in Fig. 10.* whereof it is to be seen that the copper cylinder has yielded most

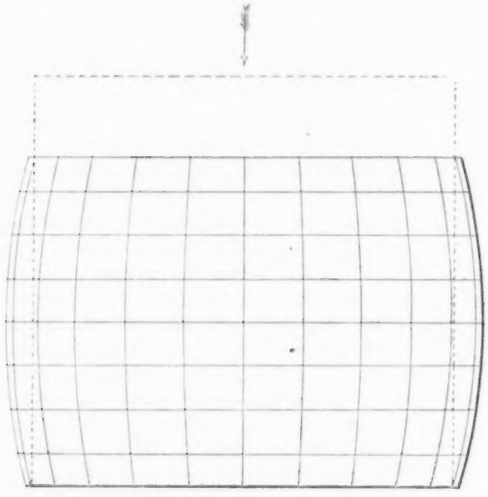


FIG. 8. Lead Cylinder after Compression.

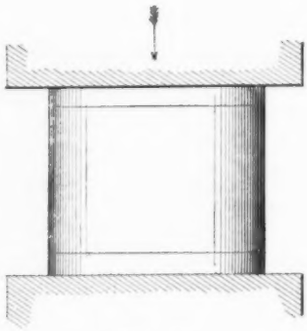


FIG. 9.
Copper Cylinder between Lead Disks.

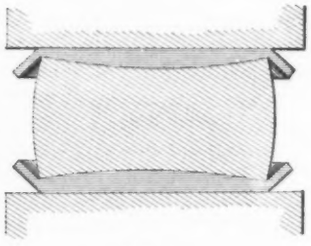


FIG. 10.
Copper Cylinder after Compression.

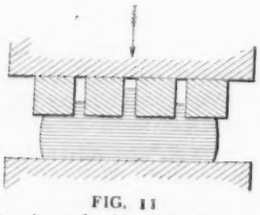


FIG. 11
Experiment showing Higher Pressure in the Middle.

FIG. 12
Effect of Compressing a Clay Cylinder between Glass Plates.

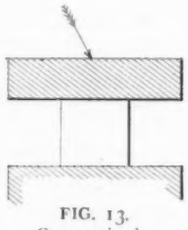


FIG. 13.
Compression by Oblique Pressure.

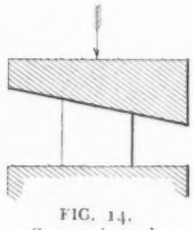


FIG. 14.
Compression under Oblique Surface.

in the middle; this can be explained by the pressure there having been the strongest, while the lead disks have not pressed so much in the neighborhood of their circumference, because they have been able to yield freely there.

That the lead disks really have been subjected to a greater pressure in their middle than nearer to their periphery, has been proved by the experiment made by Mr. Kick and illustrated in Fig. 11, in which, by pressing the lead disks between two plates, of which the upper one was perforated, he got the lead to mount the highest in the central perforation.

Professor Mohr in Dresden, and Professor Föppl (see the "Baumaterialienkunde," 1900, p. 114) think that a friction ensues between the pressure plates and the cylinder or cube, etc., which is being pressed, and that the degree of that friction will influence the deformation and the power needed for fracture, so that the resistance diminishes, if the pressure faces are greased. As proved by the tests made by Mr. Kick and described in the "Baumaterialienkunde," 1900, p. 177, it seems more likely that there has been no friction at all, when no grease was used.

Mr. Kick pressed a cylinder made of porcelain clay and the bearing surfaces of which were blackened with China ink, between two glass plates, whereby it was shown, by looking through one of the glass plates, that the blackened circle did not enlarge, i.e., that the molecules of the bearing surfaces, which at the beginning of the test touched the pressure plates, had not displaced, and that consequently no real (active) friction could arise. But around each of the black circles other parts of the materials of the cylinder were by and by placed against the glass plates as a white ring, see Fig. 12. Even when he made the test with a cylinder of vulcanized caoutchouc—practicable by hand-power only—the result was the same. It would really be astonishing, if the material should be driven outward, the forces of the pressure face being transferred perpendicularly. Whether the glass plates were bright polished, dim or coated with a very thin oil membrane, the results of these tests remained invariable.

On the contrary, the conditions changed thoroughly when the grease was put on in a thick coat; in that case, however, this coat did not act as a lubricant to diminish the friction but as one of the lead disks employed in the experiment illustrated by Fig. 10, and these lead plates having caused the copper cylinder in question to become hollow in the middle of the bearing surface, it followed therefrom that they had transferred other forces than perpendicular ones on the bearing surfaces of the interposed body, that is to say also horizontal, i.e., outward-driving, forces. By the trial with a caoutchouc cylinder only a few drops of oil on the glass plates were sufficient to enlarge in some degree the black circles.

Here we may perhaps find the key of the facts stated by Mr. Föppl—"Mittheilungen aus dem mech. techn. Laboratorium der k. techn. Hochschule, München, 27 Heft, 1900, pp. 24-28"—that cubes of cement and cubes of sandstone and granite are, when the bearing surfaces are coated with stearin or wax, crushed by about

*Charbonnier and Galy-Aché communicated at the International Congress for Testing Materials in Paris, 1900 (see the account, 1st vol., p. 235), that by tests with copper crushers, i. e., very small copper cylinders employed in military technics for determining the pressure of the powder-gas in firearms, they had found that such a one, when the ordinary, polished pressure-plates were employed, took the form of a barrel by a pressure of 3000 kg.—probably on the square centimeter—but that, on the contrary, a crusher by the same pressure kept almost its cylindrical form when its bearing surfaces were coated with a grease of graphite, and that it took the form of a hyperboloid, i.e., the form of an hour-glass, if, instead of the grease, lead disks were placed between the bearing surfaces of the crusher and the pressure plates, and Mr. Foppl (see the "Baumaterialienkunde," 1900, p. 130) found that a copper cylinder, whose bearing surfaces he had coated with stearin or wax, got a much less bulging form, though the bulging was not quite prevented.

the half and by still less (down to ⅓ to ¼), respectively, of the normal fracture load; and that the crushing is not produced according to the oblique system, but nearly parallel with the direction of the pressure. Thus it is proven that with brittle materials the outward driving of the lubricant will assist the bursting of the substance by means of horizontal stresses.

The case will be the same when we crush a stone between pasteboard disks or lead plates, these intermediate layers being pressed down into the pores of the bearing surfaces of the stone.

While with a cylinder of tough or plastic material no active friction may be presumed to arise by a perpendicular pressure between clean, horizontal pressure plates, the case becomes different when, for instance, the top plate is pressed either in an oblique direction—Fig. 13—or perpendicularly downward, but having an oblique bottom surface—Fig. 14. In these cases the deformation will depend upon the friction between the pressure plates and the material, besides, of course, upon the angle of action β of the material. The intricate relations of these cases have not been at all fully cleared up, though Professor Kick a few years ago has given a very interesting contribution in this direction in the "Technische Blätter," series 34, 2d and 3d parts, where he has employed for pressure experiments prisms of clay layers as in the excellent experiments made by him already several years ago upon the deformation of plastic materials by treatment with ordinary tools.

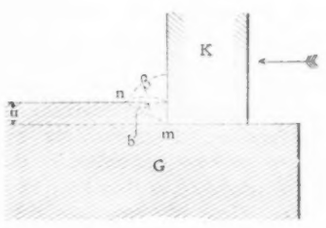


FIG. 15 Primitive Planer-Tool

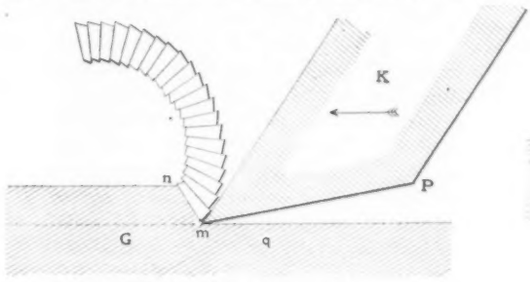


FIG. 16 More Refined Planer-Tool

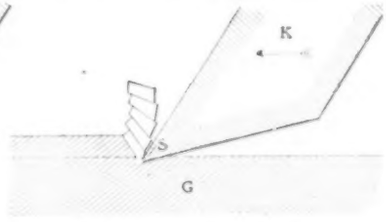


FIG. 17 Action of Planer-Tool

B. APPLICATION TO THE PROCESS OF CUTTING CHIPS.

Before going further, we will show how the matters hitherto described can serve to explain the process, when a cutting tool takes a chip, as for instance when a steel tool planes off in a planing machine the surface of some piece of work. In Fig. 15 G is the work-piece from which a tool K, of a shape the simplest possible but one which is practically inadequate, has to plane off a certain layer u by moving in the direction of the arrow and being forced forward by a sufficiently great power. In front of the tool K a sliding prism will be formed in the material, and if this is tough, a bulge will, as indicated, appear on the surface of the material (compare Fig. 8), *i.e.*, the material is upset. Here we have just the case illustrated in Fig. 4 where the part b is prevented from being displaced to the side, in the present case the constraint being against downward motion; and after some upsetting, a sliding along the face mn will be produced.

It is, however, to be expected, what has also been proved by experiments, that the sliding mentioned is more easily produced when we let the front of the tool incline backward, because the front of the tool in this case will exercise a pressure more in the direction of the sliding, on the portion of the material that is to be removed. The sliding will then take place under a somewhat different angle than that of action, and we have then approximately the case illustrated by Fig 14, where the deformation, besides depending on the angle of action, depends upon the friction between the metal and the tool.

The case of planing will now be different according to the nature of the metal. In the softest metals, as lead and tin, the sliding will be so easily produced that only a little upsetting takes place before the sliding begins, and therefore the chip will be almost continually loosened, the sliding taking place almost without interruption and being very small. In the brittle metals, as for instance cast iron, the cohesion between chip and work will cease whenever a sliding takes place, so that we do not get a coherent chip, but only fragments.

With metals such as wrought iron, copper, etc., which certainly are tough, but not as soft as lead and tin, the slidings will be effected incessantly, whereby we get the well known shape of chip shown in Fig. 16, where the steps on the backside of the chip will, in practice, be smoothed by the friction against the tool. The advantage resulting from the fact that we ordinarily do not let the bottom face of the tool rub on the work, but make use of an angle of clearance pmq, is too well known to the readers of the AMERICAN MACHINIST to require explaining here.

Practically, the edge of the tool K is never mathematically sharpened, but is somewhat rounded. In Fig. 17 it is, we presume, exaggeratedly rounded. The consequence hereof is, that the sliding-faces start nearly from the spot S, that is foremost on K, so that the material above the horizontal, dotted line through S will be peeled off; while the material beneath this line will be compressed downward and, owing to its elasticity, as shown, again rise, when the tool has passed. That a material in practice really rises, when a tool has passed, is proved by the fact that the tool will always take a fine chip when it passes once more in the same path. That the chip which is taken of a tough material is in practice always evidently upset in the direction of the movement of the tool, is to be seen, for instance, when a broad tool passes a little round hole, whereupon the hole in the chip then grows oval.

Practically, as known, the tool is mostly so shaped that its edge is not, as here assumed, right-angled but, on the contrary, oblique to the direction of the movement. Thereby we take advantage of the so-called reduced cutting angle, shown in a vertical section through the tool in the plane of its movement, which angle becomes smaller than the real cutting angle, the latter being the angle between the front and the bottom face of the tool (considering work and tool to be in the positions shown in Fig. 17). Thus we obtain that the tool cuts better, without having made the edge thinner, and that the chip does not move upward and forward in a perpendicular plane, but is screwed away sideward, so that its restraint of the forward movement of the tool occurs in less degree. However, these concerns are so well known to the readers of the AMERICAN MACHINIST, that we will dwell no longer at this matter.

(To be continued.)

France now owns 11 first-class and 10 second-class battleships, 9 armored coast-defense ships of no great value; 8 armored gunboats, 14 first-class armored cruisers, and 4 second-class cruisers, 33 protected cruisers of all classes; 1 torpedo-carrying cruiser, 43 torpedo-boat destroyers, 9 torpedo despatch boats, 40 sea-going torpedo-boats, 182 torpedo-boats of all classes, 27 torpedo-boats for use in the colonies, 6 submersibles, and 29 submarines. Germany possesses 21 battleships, of which 16 have been built since 1900, 8 armored coast defense ships, 12 armored gunboats, 4 armored cruisers, all quite new, 36 large and small cruisers, 10 old torpedo division boats, 37 large torpedo-boats, 78 small torpedo-boats, and several submarines now being built, but of which the number is not known.—*Engineering.*

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American and Swiss Turbine Practice.

It has long been the practice in certain quarters to characterize American turbine practice as inferior and to extol Swiss practice as a model for the world. We are far from deprecating the work of Swiss engineers in this field, which, in point of excellence, deserves all that has been said of it, but it is a pleasure to be able to print from the pen of so competent an authority as W. M. White a striking tribute to American work. Mr. White, it should be remembered, is a highly scientific turbine designer of the class that has made Swiss turbines famous, and in a recent conversation he spoke even more strongly than in the article which appears in another column, saying, "I take off my hat to the old line of American turbine builders."

A glance at the lines on which the two schools of turbine practice have developed may prove of interest, as it illustrates again how engineering practice is the outgrowth of environment and conditions, and how the final gage of excellence lies in results and not in methods.

The water powers of Switzerland are mountain streams involving every possible combination of head and volume of water, a given combination of head, volume and of power required, seldom or never repeating itself. Under these conditions every turbine is a problem apart, to be solven by analytical methods; and such methods naturally and necessarily became characteristic of Swiss practice.

In this country, on the other hand, that is until recently, the conditions were the opposite of these. If we reflect on the territory which has supplied the market for American turbines we shall find that it lies chiefly in the Atlantic seaboard and the eastern slope of the Mississippi valley, the territory of the Allegheny mountains scarcely counting, as because of its proximity to great coal fields, such power developments as exist there are chiefly steam plants.

The nature of the territory tells the story of the conditions, which are uniformly those of low and moderate heads; this being especially true of New England, where American turbine practice received its first impetus and obtained its hall mark of character.

The development of water powers in New England—notably at Lowell and Holyoke—under the systems of distributing canals giving fixed and moderate heads, provided at once a large demand for turbines to meet such conditions; and the building of the testing flume at Holyoke provided a means of experimental work which was, and, so far as we know, still is, unique, and it was for many years the dominating influence in turbine development. Those who look with disrespect on American turbine methods do so because they have been largely empirical, or, to use a common expression among their detractors, "these wheels have been whittled out with a jack knife," and the statement is not far from the truth. The word jack knife is, of course, used as a term of reproach, but should it be? Change the expression a little, and while saying the same thing it loses its sting. The American turbine has been developed by the *experimental method*, and certainly the engineer should be the last one to decry the basing of practice on experiment. Moreover, this experimental work has had behind it the highest order of intelligence and it has produced results to the excellence of which Mr. White bears willing witness.

On the Pacific slope the conditions have more nearly approximated those of Switzerland, and there has taken place one of the most brilliant developments that hydraulic engineering has ever seen—the impulse wheel, of which the Pelton was the first of high grade and than which no achievement of American engineers is more creditable.

Mr. White describes, and we do not need to repeat here, the changed conditions which are now coming over the turbine field in this country and which make necessary the adoption of the analytical method of design as it has long prevailed in Switzerland; but that this will retire or seriously affect the older methods is not to be expected. Beyond doubt the great majority of wheels installed in the future will be produced as they have been in the past. They will go into their wheel pits, out of sight and out of mind, performing their work at a minimum of cost and at a maximum of efficiency and repeating year by year their testimony to the excellence of the jack-knife method of design.

Machine-Tool Prices.

A forced sale of a large lot of machine tools which had been installed in a shop in Lowell, Mass., and used but little, is attracting considerable attention because the prices realized were in some cases higher than new tools of the same make could now be purchased for. Obviously the reason for this was that the tools were there on the floor ready for immediate delivery, and it is not news to those in the business that some users are perfectly willing to pay a premium for immediate delivery of tools which cannot now be had of the makers short of from six months' to 18 months' time, and for lack of which many manufacturers are actually suffering.

The sale was large enough to make it worth while to advertise it well, so that buying interests were well represented, and the state of the market was probably pretty accurately reflected.

On this showing it would appear that machine-tool builders generally would be justified in an advance of prices, and also

that the general condition is such that those of them who have in hand the necessary funds for the purpose, earned from the business, are justified in enlarging their plants sufficiently to enable them to fill orders within a reasonable time.

It is of course always somewhat hazardous to put up shops on borrowed capital, but on the other hand no one knows how long the present demand may last, nor to what proportions it may grow. It would seem therefore that where a machine-tool builder has capital earned from the business, and which can be used in extending it, there is scarcely better or safer use to which it can be put. Fifteen years ago few, if any, of the most far-seeing men had any idea to what proportions the machine-tool industry was to grow by this date. It may easily happen that there is a similar surprise in store for the next fifteen years. At any rate, it seems an incontrovertible fact that machine tools are by every recognized commercial law, worth more than they are generally selling for today. And if they are worth more, the builders of them ought to receive more and to the extent that it is possible the workmen ought to participate in the advance, as in fact they are generally doing, and will undoubtedly continue to do, so long as the present general complaint of the scarcity of good men continues. It is a manifestation of the law of supply and demand, and no one can justly find fault with the working of that law.

Superheated and Overheated.

Some time ago we referred to the use of the term "overheated steam" by one of our consuls when he meant superheated steam. *Engineering News*, commenting upon this, remarks: "Strictly speaking, 'superheated' steam and 'overheated' steam mean the same thing; but it looks queer, nevertheless," etc. We beg to differ. Perhaps our contemporary is correct if we are to consider only the etymology and derivation of the words. But the term overheated has come to have a definite meaning, which does not at all apply to superheated steam. We all know that the term overheated as applied to horses, men, steel, or bearings, means heated too much—to a more or less injurious degree—to a higher temperature than was intended or is considered safe. Such is the universal meaning of "overheated," and if when superheated steam came into use it had been called "overheated steam," a distinctly wrong impression would have been conveyed. True enough the dictionaries tell us that the prefix super is equivalent to over, but they also tell us it is equivalent to above or beyond, and it is in this sense that the term is used in mechanical science. If superheated steam, i.e., steam heated somewhat above the temperature corresponding to its pressure, should be still further heated to an impracticable, dangerous or wasteful extent, then it might properly be called overheated.

New Publications.

"Die Schiffsschraube," by Albert Achenbach, "Oberlehrer an der Königlichen höheren Schiff- und Maschinenbauschule zu Kiel." Vol. I. "Ihre Entwicklung und zeichnerische Darstellung." Kiel, Germany, Robert Cordes, 1906. Light cloth binding, 84 6½x9¼-inch pages; 25 plates and 2 tables. Price 10 marks.

This is the first volume of three by this author, upon the subject of the screw propeller, the portions which are to be treated in each volume being as follows:

Volume I. Historical development and representation by drawing.

Volume II. Construction.

Volume III. Performance and calculation.

The first chapter in this volume, which is preceded by a bibliography, sets forth the geometrical rudiments. Then comes a sketch of the history of the marine screw. In England F. P. Smith, and in America John Ericsson, the famous Swedish engineer, are given by the author the honor of applying the screw to marine propulsion. The work of John Stevens, which is illustrated in the Morton Memorial (reviewed at page 689) does not appear to be mentioned, though it was done in 1804, while Ericsson's patent was taken out in 1836. Nearly 30 pages and the greater part of the plates are taken up with the drafting portion of the subject, including descriptive geometry and approximate methods of development of the surface of the screw. The Zeise and the Niki propellers, two German inventions, are the subjects of the last chapter, tables being given to show the results of comparative tests of different kinds of propellers upon a yacht, a species of test which has, however, been shown by experience to be inconclusive. The folding plates are arranged so that when one is opened out no part of it is concealed by the adjacent pages of the book, a plan which it would be well if more book-makers using insets would follow. Moreover, all through, the pages have a wide margin in which are inserted the plate numbers and figure numbers referred to in the text alongside, which is exceedingly convenient for reference since the illustrations are not printed in the text. To our eyes, however, it is a pity that the plates are all lettered in round writing, which is perhaps ornamental but must certainly yield the palm for clearness to plain Roman or gothic letters.

"Standard Methods of Testing and Specifications for Cement." Edited by the Secretary and published by the Committee on Standard Specifications for Cement of the American Society for Testing Materials. 32 6x9 inch pages, paper cover.

This pamphlet contains an introduction giving a history of the cement committees of various organizations, a copy (with illustrations) of the A. S. C. E. report on uniform tests of cement, a report to the Society for Chemical Industry on a proposed uniform method for the analysis of limestones, raw mixtures and portland cements, and a copy of the report of the committee on standard specifications for cement of the American Society for Testing Materials. The pamphlet is very instructive and useful to those concerned with a material of widespread and rapidly growing application.

"Things that are Usually Wrong." By John E. Sweet, 52 5¼x7½-inch pages with 50 illustrations. Hill Publishing Company, New York. Price 50 cents.

This little volume is, in the main, a reprint of the articles which have appeared in these columns from time to time under the same title. The habit of being satisfied with a thing because it is common practice is inherent in most people, but not in Professor Sweet. His habit, on the contrary, is to point out constructions which through familiarity are accepted as right, but which are in reality wrong, and usually so obviously wrong as to cause wonder that they should need to be pointed out. Few machines designers can read this book without finding obvious methods of improving their work if they will but use them.

Running at the rate of 60 miles an hour just south of Reading, a train of the Philadelphia & Reading Railway, filled with passengers, came to a sudden stop last night, halted by the red light of a block signal. After waiting the minute in which a train is supposed to clear the short blocks, the engineer proceeded with caution, expecting a wreck, or at least a broken rail. An inspector was sent out at once, and found the red still showing. A thorough examination overhead and above ground showed no defect. The inspector finally removed the top of the underground case, which contains the underground connections with the rails. A garter snake, 22 in. long, lay comfortably coiled, its head cushioned on the delicate spring, depressing it so that it made the contact necessary to set the signal at danger. The reptile had reached the hight of its fame and met death in so doing.—*Allentown Leader.*

Contrary to our expectations we find no foot note explaining that this is the *Leader's* prize story, the result of an exciting competition between all the romance writers of Pennsylvania, New Jersey and Delaware. It deserves the prize, however; at least for this season. The Massachusetts sparrow that lit on the counterweight of an inclosed disk signal will now take a back seat or, rather, roost in the rear row.—*Railroad Gazette.*

There are said to be 75,000 electric signs in the United States.

The Morton Memorial Laboratory of Chemistry of Stevens Institute of Technology.

This building, which is now completed, is one of the finest of its type in the country. The building is without a basement and consists of three stories, the attic above the third floor remaining in the rough and being utilized for storage, etc. All of the rooms are very well lighted, which is a most important condition affecting the usefulness of a chemical laboratory.

On the right of the corridor on the entrance floor are a toilet room, oil and gas analysis room, coat room, janitor's room, assay room with its smaller balance room, electro-chemical laboratory and main stock room, which latter is connected by a stairway with a supply room on the second floor and is provided with a lift. On the left of the corridor are the professor's office, his private laboratory and balance room, assistant professor's private laboratory, and machinery or fan room. From the entrance lobby at the front of the building an iron stairway with slate steps leads from the first floor to the second or main laboratory floor. Beneath the stairway, and extending a few feet below the first floor level, is a large fireproof vault for preserving the institute's records, etc.

The stairway from the first floor leads to a lobby on the second floor, from which the large analytical laboratory designed for both qualitative and quantitative analysis is entered. This laboratory, with its combustion or ignition room, hydrogen sulphide room, supply room and balance room on a mezzanine floor, occupies the entire second floor.

A second stairway leads from the lobby on the second floor to a corridor on the third floor, which extends to the lecture room in the northeasterly end of the building. On the right of the corridor are a toilet room, office, library and lecture preparation room; the last-named room is connected with the second-floor supply room and the first-floor stock room by the lift already mentioned.

All the rooms on the right of the third-floor corridor are comparatively narrow, while on the left are a large recitation room, the Morton Memorial room and a narrow corridor leading to an unfinished store room and workshop under the lecture-room seats. The large lecture room and its preparation room occupy all of the easterly end of this floor.

The building, with its fixtures, was planned by a committee from the institute faculty, with Prof. D. S. Jacobus as its chairman, and the plans were finally carried out by Messrs. Ackerman and Partridge, architects, of New York. The building was erected between March, 1905, and February, 1906, at a cost of about $150,000. In its construction the chief consideration was for its practical utility, and the architects have succeeded in combining this with a pleasing architectural effect. The exterior walls are built of red, hard-burned brick upon a granite base. The trimmings are of limestone and the steps leading to the building are of granite. The structure is built throughout on the principles of fireproof construction, the building material being steel, brick and cement, with stone trimmings. The interior walls and partitions are laid with buff-colored brick, with a base three courses high of red pressed brick. The woodwork throughout the building, with the exception of a few floors, is of quartered oak having a dark finish. The floors throughout the building have a reinforced cement base; in the laboratories and preparation room the floors are of asphalt, while the lecture room, recitation room, library, balance rooms and offices have floors of maple. All ceilings except those of the Memorial, lecture and recitation rooms are of cement.

The heating is by the direct steam system. The ventilation is by positive air pressure produced by a large blower on the first floor, the fresh air being taken from the north side of the building and filtered through cloth, it enters the various rooms through registers placed near the ceilings; and in the winter time it is heated by steam coils in the fan room. An elaborate system of hoods connected to a large exhauster driven by a 16-horsepower electric motor removes the vitiated air and fumes from the laboratories and other rooms.

The provision of all conveniences required in the laboratories is very complete and carefully worked out. All of the rooms in the building are equipped with gas burners for illuminating purposes, and all working tables, etc., are fitted with fixtures for Bunsen burners, of which there are about three hundred. All pipes for gas, steam, water and drainage, as well as the large tile pipes for conducting the waste gases from the hoods are suspended from the ceilings, and every joint and length of pipe is perfectly accessible, so that any leak may be readily detected and repaired. Fire hose, fire extinguishers and fire escapes are provided. The electricity used in the building is obtained from the Carnegie Laboratory of Engineering. Tin-lined iron pipes are provided to conduct distilled water to the rooms in which it is needed, and they are fitted with self-closing cocks, and in any parts where contamination might take place the faucets are silver-plated.

The course in chemistry in this Institute being designed for the engineer, the laboratory does not include rooms such as an organic chemistry laboratory, a physiological chemistry room, or an agricultural chemistry room which are found in some college laboratories of chemistry, but would be superfluous here. Chemistry is studied by all students during the first three years, including classroom and laboratory work, the latter of which as usual commences with qualitative analysis, and is continued with a course in quantitative analysis.

The two most important rooms in the building are the large laboratory of analytical chemistry on the second floor, and the lecture room on the third floor, and it is probably worth while to take space to give a few of the particulars regarding these rooms.

LABORATORY FOR QUALITATIVE AND QUANTITATIVE ANALYSIS.

This large laboratory, which with its supply room, combustion room, and hydrogen sulphide precipitation room occupies the entire second floor, is 91 feet long, 48 feet wide, 17 feet 6 inches high, and is furnished with 16 double working tables, 6 cases of general reagent shelves and closets, 7 sets of wall shelves, and 6 groups of drying ovens with fixed tables beneath them. The tops of the working tables are of Alberene stone and have stone troughs running along them which discharge into large earthenware sinks.

Each working space is provided with a down-draft hood having a 10x12-inch opening, 17 inches above the table top, and a pipe 4 inches in diameter, constructed of sheet iron, painted on the outside with aluminum paint and on the interior with pitch. As all work in which fumes are generated is performed under the hood and the draft is very strong, the laboratory atmosphere is kept quite free from fumes.

The combustion room opens directly into the main laboratory and is 16 feet by 12 feet 6 inches, and is equipped with blast lamps, combustion furnaces, etc., and is used especially for blast-lamp work in the ignition of precipitates.

The hydrogen sulphide room is 21x9 feet, and is provided with two large generators for hydrogen sulphide gas, all work requiring the use of this gas being performed in this room. The provisions for ventilating the room are very thorough, so that there is practically no odor of hydrogen sulphide in it. It may be well to state for the information of those not familiar with chemistry that this gas has a strong smell of rotten eggs.

LECTURE ROOM.

The large lecture room on the third floor is 53 feet wide, 40 feet from front to back, and 18 feet in hight at the maximum, and 8 feet from the highest level to which the inclined floor rises. The main entrance is at the lowest level of the lecture-room floor. The floor is of maple with a cement base. The problem of providing sufficient light for this large room was one which required especial attention, and it was satisfactorily solved by providing a saw-tooth construction of the roof above the lecture room, which contains three skylights admitting light from the north. There are seats for 198 in-

dividuals, the seats have fixed writing tablets and are placed on a stepped floor, the rise in the steps being carefully calculated so that every student has a splendid view of the entire lecture table. Since the roof is supported by trusses the view is not obstructed by any columns. The lecture table is 28 feet long and 2 feet 8 inches wide, and is provided with all necessary conveniences for the performance of chemical experiments and operations. Moreover, there is alongside of the lecture room, and communicating with it, a preparation room 57 feet 6 inches long, in which the apparatus for the experimental lectures may be prepared.

The Morton Memorial room is 31 feet 6 inches by 20 feet, and 13 feet 6 inches high. It has an inlaid oak floor with cement base.

Across the corridor from the Morton Memorial room is the library, 20 feet 3 inches long by 7 feet 9 inches wide. The purpose of this room is to contain only such books and journals as are immediately needed for consultation by the students in their laboratory work, the large chemical library being in the main Institute building.

We cannot afford space for a detailed description of the numerous rooms in this building. We can only say that it does not appear that anything has been overlooked, and its possession should be a great advantage as well as a source of pride to the Institute.

Legal Notes.

BY E. P. BUFFET.

CASE OF WATER-WHEEL GOVERNOR AT PAPER MILL.

The Supreme Judicial Court of Maine has passed upon cross-actions between a water-wheel-governor company and a paper company. The governor company, it appeared, had sold the paper company four automatic governors and balanced relief valves to be connected with grinders at the paper mill and had agreed in the contract to send a man to erect and adjust them. During the adjustment of one of the governors an accident happened, including the bursting of a water-wheel case, and the paper plant was damaged by the rush of water. Consequently, the paper company declined to remit the balance unpaid for the apparatus furnished and not only defended an action to recover payment but brought a counter-suit to recover for the injury done to the plant. The Supreme Court has rendered judgment for the governor company in both cases.

A paragraph of the contract read as follows: "In consideration of the above guarantee you hereby agree to purchase said governors and relief valve and to pay for the same and the costs of said connections in cash within one month of date of shipping documents. Also to pay for a man to erect and adjust said governors and relief valve at the rate of five dollars ($5.00) per day for his time, with his necessary traveling expenses added thereto, in cash, when the work is done."

The court, describing the plant of the paper company as it appears on the record of the case, gives in part the following particulars: "The feed pipe has a fall of about 110 feet and is about 1100 feet long and about 10 feet in diameter, and the water column in the flume weighs substantially 6,220,800 foot-pounds [pounds?] and when at working speed contains 222,600 foot-pounds of momentum energy or 4119 horse-power. A serious accident to the defendant's mill occurred during the work of installing one of the governors to regulate this momentum."

In defending the action to recover the price, the paper company denied that under the terms of the contract it was compelled to pay within a month from the date of shipment unless a suitable man had been sent to erect and adjust the apparatus and had completed his work within that month. But the court holds that under the terms of the contract (which have not here been quoted in full) the stipulation as to the erector was not a condition precedent to payment, but was independent of the contract of sale, which had been executed upon shipment of the goods. As a matter of fact, the court does not regard the evidence as establishing the negligence or incompetence of the erector sent.

The buyer contends further that there was an implied warranty that the apparatus supplied would be suitable for its plant. The court, however, holds that such an implied warranty is excluded by certain express warranties in the contract and by the fact that the goods were such as the vendor, in the ordinary course of his business, manufactured for the general market. So the buyer could not properly have withheld payment on that ground even had the appliances been unsuitable.

The question of their unsuitability is discussed in considering the cross-action by the paper company. In this the purchaser had sought to recover for alleged injuries to its plant as due to the insufficiency of the appliances to meet the conditions at the mill or to negligence in installation. In treating of this question the court utters the following engineering opinion:

"The absence of any further attempt to install the governors or any instance of their successful use in connection with grinder units, and particularly under the same conditions as those prevailing at the paper mill where the force to be regulated was water power of extraordinary character, makes it difficult to decide with certainty as to the practicability of this apparatus for the purpose required, but the weight of evidence, particularly that in relation to the final accident to the water-wheel case, indicates that this automatic governor could be used under such conditions only with great and constant risk, because from its sensitiveness and the changes of pressure on the grinder wheels, it was liable to shut and open the gate with great suddenness and subject the flume to violent strain from the enormous weight of unelastic water. Apparently no safeguard could prevent a recurrence of the accident which befell the wheel case. It seems to have broken from no inherent weakness, but from the overwhelming pressure suddenly brought to bear upon it."

It would appear that the paper company's engineers must have understood the conditions from knowledge of this water power and the same type of governor as used in the company's other plants. The purchaser is therefore presumed to have assumed the risk. Besides, it is stated that the seller had expressed some uncertainty as to what would be the result of its use in this case.

It is not determined whether the accident to the grinders was occasioned by some movement of the governor itself or by an injury to the shaft of the water wheel existing before the erector took charge of the manipulation of this machinery. The paper company contends that the sudden closing of the gate and bursting of the wheel was caused by the superintendent of the governor company (who had come to the scene of action) regulating the movement by hand. It would appear that this was done upon hearing a cracking. If so, as an emergency matter, he could hardly be held negligent if he acted according to the best of his judgment at the time, even though it may now seem that he was injudicious. But the evidence tends to show that no manipulation of the governor could produce a quicker effect than its automatic action.

63 Atl. Rep., 555.

FLY-WHEEL ACCIDENT.

An Indiana court has awarded damages on the ground of injury to an employee from the bursting of a fly-wheel in a sawmill. The Appellate Court has, however, reversed the judgment for the reason that the complaint did not sufficiently aver that the fly-wheel was defective.

76 N. E. Rep., 644.

Personal.

C. W. Benson, who has been a foreman with the Stanley-G. I. Electric Manufacturing Company, of Pittsfield, Mass., for 11 years, has resigned.

The address is desired of C. G. Bunnell, who was at one time draftsman for the American Turret Lathe Company, and was afterward with the American Ship

Windlass Company. Anyone knowing the address will confer a favor by sending it to the editor.

Prof. Mansfield Merriman, who for many years has been professor of civil engineering at Lehigh University, has been granted leave of absence for one year and will spend the greater part of that time in practice as a consulting engineer, associated with Clarence W. Hudson, at 45 Broadway, New York. Mr. Hudson has been assistant engineer of the Phoenix Bridge Company and has tendered his resignation to take effect September 1, on which date the consulting engineer office referred to will be opened. Both these men have done notable work in connection with bridge construction, of which they will make a specialty.

Obituary.

Dwight Slate, president of the Dwight Slate Machine Company, Hartford, Conn., died at Hartford July 31 after being confined to his bed for ten days as the result of a shock.

Mr. Slate was born in Gill, Franklin county, Mass., May 29, 1816 and was therefore a little more than 90 years old. At the age of 17 he entered the machine shop of Eli Horton at Windsor Locks, Conn., now the E. Horton & Son Company, as an apprentice and before the term of his apprenticeship expired he was made a partner in the business. In 1845 he formed a partnership with the late Major F. M. Brown, the name of the firm being Slate & Brown. The firm built a large shop in Windsor Locks for the manufacture of textile machinery and fitted up various textile mills in Massachusetts and Connecticut. This company also was one of the first to manufacture iron planers. Slate & Brown had the sub-contract from Colonel Colt for the barrels and cylinders of revolvers contracted for by the United States Government and in the Mexican war one regiment was equipped with the revolver, the tools for the manufacture of which were invented by Mr. Slate.

In 1850, Mr. Slate went to Augusta, Ga., to take the superintendency of the Augusta Machine Works. Upon the approach of the Civil war he returned to Hartford and entered Colt's Armory as a general contractor. There he made important improvements in methods and apparatus for manufacturing fire-arms, including an improved rifling machine, and during the war he rifled on contract at the armory 120,000 gun barrels. It was during his stay at Colt's that he invented his taper-turning attachment for engine lathes. The patent he afterward sold to the Pratt & Whitney Company, then just starting in business. It is stated that he was offered for the attachment either $10,000 or a third interest in the business, and chose the former.

After the war Mr. Slate entered the employ of the Pratt & Whitney Company, where he designed a line of lathes and other tools, and later went with the Berryman Regulator and Alarm Company and while there invented the Berryman heater. In 1876 he started a shop in Hartford for the construction of special machinery and began the manufacture of his cutting-off tools, center grinders, automatic gear cutters and sensitive drills. The concern was incorporated under the name of the Dwight Slate Machine Company in 1885. Mr. Slate was one of the best known mechanicians in the country and possessed excellent judgment combined with unusual inventive ability. His was a life of very great usefulness.

Charles Addison Bragg, district office manager of the Westinghouse Electric & Manufacturing Company, Philadelphia, Penn., died at that place July 29, after an illness of over two months' duration. Mr. Bragg was one of the pioneers in the electrical business, he having been associated with the United States Electric Lighting Company as early as 1882. His connection with the Westinghouse Electric and Manufacturing Company began in the year 1889, when he was made the manager of the Philadelphia office, which position he filled successfully up to the time of his death. He was born in Franklin county, Mo., 56 years ago, and was a graduate of Yale University.

Thomas F. Morrin died at his home, in Jersey City, July 31, of apoplexy. He was 58 years old. He formerly lived in Brooklyn, where he was president of the Morrin Climax Boiler Company. Mr. Morrin was the inventor of the Climax boiler. When he removed to Jersey City he became chief engineer of the P. Lorillard Company, a place he held for more than twenty-five years.

Business Items.

The New England office of the National-Acme Manufacturing Company, of Cleveland, Ohio, has been transferred to 95 Liberty street, New York. M. M. Brunner will continue in charge.

The Electro-Dynamic Company, of New York, is making preparations to enlarge its plant at Bayonne, N. J., in order to provide for its increased business, the present facilities being taxed to the utmost.

The Independent Pneumatic Tool Company, Chicago, Ill., has appointed Lake, Hale & Co., 11 Front street, San Francisco, as its exclusive Pacific Coast representatives. This company will carry a complete line of the "Thor" tools.

Charles H. Besly & Co., of Chicago, will exhibit at the Olympia, London, Exhibition, which is to be held from September 15 to October 17 next, their Besly spiral grooved steel disk grinder and their Helmet spiral paper and cloth circles.

The Bath Grinder Company, Inc., Fitchburg, Mass., has recently been reorganized and has filed a certificate of incorporation at the State House in Boston. This certificate shows that John Bath is president, Arthur L. Goodnow vice-president and Robert D. Gould treasurer and clerk. The company has grown considerably of late and has moved into greatly enlarged quarters with much improved facilities for handling quantities of work.

Manufacturers.

The National Foundry Company, Erie, Pa., will erect a $45,000 addition.

The Wellknit Hosiery Company, Harrisburg, Penn., will erect a new mill.

The American Lubricator Company, Detroit, Mich., will erect a new plant.

D. Goff & Sons, Pawtucket, R. I., will erect a new power plant for their own use.

The American Bar Lock Company, Philadelphia, Penn., will erect an addition.

Spielmann Bros. & Company, Chicago, Ill., will erect a cider mill in Coloma, Mich.

J. Lichtman & Son, Newark, N. J., leather manufacturers, will put up a new plant.

The Union Metallic Cartridge Company, Bridgeport, Conn., will build an addition.

The Co-operative Seamless Wire Company, Pawtucket, R. I., is building a new factory.

The Nagle Engine and Boiler Works, Erie, Pa., will erect an addition to its boiler shop.

The Chas. Boldt Glass Company, Cincinnati, Ohio, will erect a three-story addition.

The National Broom Company, Lockport, N. Y., is contemplating the erection of a new plant.

The American Rivet Company, New Haven, Conn., will build an addition to its plant.

The International Pulp Company, New York, will rebuild its burned mill at Hailesboro, N. Y.

A one-story boiler house will be erected for John J. Campbell, finishing works, Philadelphia, Penn.

An addition, to cost about $50,000, will be built to the planing mill of Randall Bros., Atlanta, Ga.

The Miehle Printing Press and Manufacturing Company, Chicago, Ill., has bought a site for a new plant.

The Delaware Hosiery Company, Wilmington, Del., will erect a new three-story factory to cost $50,000.

The G. Drouve Company, Bridgeport, Conn., which manufactures sheet-metal products, will erect a new plant.

The United States Sugar and Land Company, Colorado Springs Colo., will erect a plant at Sheridan, Wyo.

A two-story machine shop to cost $10,000 will be built for the J. J. Stokes Machine Company, Philadelphia, Pa.

The American Rolling Mill Company, Chicago, Ill., has purchased a site for a new plant, to cost about $200,000.

Plans have been prepared for a turbine pumping house for the United Gas Improvement Company, Philadelphia, Pa.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox computers, 75 Broad St., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Good tool or machine specialty wanted. Give full particulars. Automatic, 660, AM. M.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Structural and mechanical drawing work solicited. Joseph H. Eastwick, Jr., 2260 N. 53d St., Philadelphia, Pa.

Special machinery accurately built. Screw

machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

We have a modern machine-shop equipment and are prepared to design and build to order high-grade special machinery and tools. Cummings Machine Co., 182 William st., New York.

Wanted—Back numbers of AMERICAN MACHINIST and MACHINERY, from January, 1900, to December, 1905. State price. T. J. VW., Suite 412, Arbuckle Building, Brooklyn, N. Y.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

The University of Cincinnati has a few positions to offer energetic young men who desire to take an engineering course while supporting themselves in large measure by working as apprentices in the machine plants of Cincinnati. For information apply to Secretary, University of Cincinnati, Cincinnati, O.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Wanted—Agents in every State to handle exclusive territory on the Cone Gas Generator, which generates coal gas for stationary engines from 25 h.p. up, reducing the cost to 1/5 that of steam power; agents must be conversant with machinery business and devote entire time to the work. Cone Gas Machine Company, 1036 Majestic Bldg., Detroit, Mich.

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Excellent machine-shop building, with power, in Philadelphia; 60x90 feet, three stories, solid ground floor. Box 545, AM. M.

For Sale—Going machine shop, situated in northern Ohio; natural gas; will bear strict investigation; good reason for selling. Address Box 525, Tiffin, Ohio.

For Sale—One 50-h.p. gasolene engine, used only a few months and good as new; also one 25 h.p. Address Detroit Egineering Works, Chene and Guoin streets, Detroit, Mich.

For Sale—One plain tank, 5'6"x9'8"; one Hazelton heater, 4'x23'4"; one expansion tank, 5'9"x23'5"; one Berryman heater, 4'x 20'. Studebaker Bros. Mfg. Co., South Bend, Indiana.

Business Opportunities.

For Sale—A complete manufacturing establishment, consisting of machine shops, erecting shops, boiler, blacksmith and pattern shops, foundry, core and casting rooms, offices, six acres of land; arranged with side tracks connecting trunk lines; very convenient to the trade centers and coal, iron and coke fields. The works are equipped to manufacture four-valve automatic steam engines; the tools are modern, some of them new; the buildings are in good condition and the works are ready for action. These works are situated in Virginia and will be sold cheap for cash. For particuars address Post-office Box 656, Knoxville, Tenn.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Wanted—Position as shop superintendent or general foreman; experience 14 years on light and heavy machinery, tools for cutting and forming sheet metal or wire; will be open for position Sept. 1. Box 886, AM. M.

ILLINOIS.

Assistant superintendent, or chief draftsman, with firm of good standing; technical graduate, M. E., 10 years' broad experience designing general and special machinery. Box 889, AMERICAN MACHINIST.

MARYLAND.

Position as superintendent; experienced in pattern, foundry and machine shop; good executive and organizer; well up in labor-saving appliances and modern manufacturing; can produce results; now holding position of responsibility; good reason for seeking change; references. Box 883, AMERICAN MACHINIST.

MASSACHUSETTS.

Expert planer hand desires position as foreman of planers; experienced; would operate in small shop; hustler. Box 812, AM. MACH.

NEW JERSEY.

Draftsman—Young man having 5 years' shop and 2 years' drafting experience desires position in or near New York. Box 876, AMERICAN MACHINIST.

Engineer, with a record of over 25 years in hydraulic machinery, steam engines, air compressors and condensing apparatus, desires to enter the services of a large engineering firm where high ability is appreciated. Box 893, AMERICAN MACHINIST.

Foreman — Toolmaker wants position as foreman for toolroom or intricate manufacturing; sixteen years' experience; can furnish first-class reference as to both mechanical and executive ability. Box 874, AMERICAN MACHINIST.

NEW YORK.

Draftsman solicits home work evenings, sketch, detailing or tracing; terms moderate Box 895, AMERICAN MACHINIST.

Mechanical draftsman with 9 years' experience wishes to change; New England or Connecticut preferred. Box 881, AM. MACH.

Cost accountant, purchasing agent, assistant superintendent, good systematizer, 10 years' experience, desires position. Box 900, AMERICAN MACHINIST.

Mechanical man, 30, experience transmission, general mill, machine, cams, drafting, designing, automatic work, desires change. Box 880, AMERICAN MACHINIST.

Mechanical draftsman, having eight years' experience, together with four years of practical shop work, desires position. Box 888, AMERICAN MACHINIST.

General foreman, successful in producing first-class work at satisfactory cost, varied experience in high-grade machinery, master machinist, desires change. Box 854, AM. M.

Experienced superintendent and buyer, several years with present firm; light or medium work; rapid production, with interchangeability, cost, stock, and tool systems. Box 896, AMERICAN MACHINIST.

Position wanted by a technical graduate, eight years' experience on electrical machinery, last three years fully responsible superintendent's assistant with large European concern manufacturing steam turbine dynamos, 2-3000 kw. Box 887, AMERICAN MACHINIST.

Wanted by young man—technical-school graduate, with four years' experience in the mechanical line—a position with an engineering or manufacturing concern. I am at present employed as draftsman and designer, but would like position in some other department. Box 890, AMERICAN MACHINIST.

Technical graduate—American, 20 years' practical business, machine shop and foundry experience, modern methods, energetic, good organizer and executive, successful in producing maximum output at low costs, now superintendent of manufacturing machine shop and foundry employing 250 men—will accept general business management, but prefer works management only; best of references. Address Box 897, AMERICAN MACHINIST.

OHIO.

Mechanical engineer — German-American, good salesman, with large experience and thorough technical training, having extensive acquaintance among manufacturers and business men in Germany and England—wishes to represent American house, with residence in Germany. Apply Box 873, AMER. MACHINIST.

PENNSYLVANIA.

Mechanical engineer, general mill work, would accept position as chief draftsman or assistant superintendent. Box 884, AM. M.

Mechanical engineer with large experience wants position as chief draftsman, superintendent, master mechanic or as mechanical salesman; experience on rolling mill, blast furnaces, engine work, special machinery, etc.; charge of work for many years. Box 882, AMERICAN MACHINIST.

TEXAS.

Technical graduate desires position in mechanical line, with chance of advancement; three years' machine-shop experience and one in college shop. Box 850, AMER. MACHINIST.

WISCONSIN.

Designer, with extensive experience on special machinery and tools for manufacturing purposes. Box 898, AMERICAN MACHINIST.

WEST OF MISSISSIPPI.

Young man—energetic, single, age 22—wishes steady work with chance to advance; lathe or planer preferred; 3½ years as all-around machinist. Box 885, AMER. MACH.

Position wanted by young man in power plant; knows all about steam machinery; have indicators and calorimeter; desires position as second and oiler. Box 877, AM. M.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

ILLINOIS.

Wanted — A thorough up-to-date superintendent to take charge of shop employing about 250 men and building a line of pumps and hydraulic machinery; plant located in middle West. Address Box 801, AMER. MACH.

Wanted, draftsmen — We want capable draftsmen of either electrical, mechanical or general experience. If you would like to change your position or its location, write and tell us about the character and extent of your work. Address, giving full particulars, to Western Electric Company, Dept. N. 29, Chicago.

Wanted—An experienced factory superintendent for the manufacture of a variety of metal specialties; man must be of good character, reliable, painstaking, mentally alert, and a thorough master of detail. The factory is new and well equipped. Salary $2000 per year, but superintendent must make cash investment of $3000 and contract for three years. Box 871, AMERICAN MACHINIST.

MARYLAND.

Foreman for machine shop working 25 hands. Box 875, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted — Draftsman, with knowledge of shop methods, for jig and fixture designer. Deane Steam Pump Co., Holyoke, Mass.

Skilled man accustomed to spiral gear cutting; must have ability and good references. Boston Gear Works, Norfolk Downs, Mass.

Good mechanical draftsman — State age, education, experience and initial salary expected. Address General Electric Co., West Lynn, Mass.

Wanted in New England, competent draftsman and designer for concrete construction; must be posted on latest methods; state age, experience and salary expected. Address Box 829, AMERICAN MACHINIST.

Wanted, more men for our new factory—To meet the demands of our increased business we need skilled men on spiral gear work, turret machines, screw machines and gear cutters; permanent jobs for the right men. Boston Gear Works, Norfolk Downs, Mass.

Wanted—Corresponding assistant to manager of factory; must be practical and experienced, well posted upon systematic and scientific methods of estimating on varied mechanical work; gear specialist preferred; also one thoroughly experienced shop manager. "Gears," Box 831, AMER. MACHINIST.

A practical machinist, capable of handling fine and accurate work, or, if necessary, getting out the ordinary class of work in money-making time. There is a field in special machinery and the advertiser has shop with established business along this line, which can be increased with profit. To the right man with large experience an interest with charge of the shop is offered. Investment of about $5000 would be advantageous. I am not looking so much for the capital as the man. In answering, state what your experience has been, to insure answer. Address Box 894, AM. M.

MICHIGAN.

Machinists wanted—A first-class layer-out and several first-class floor hands on electric traveling-crane work. Northern Engineering Works, Detroit, Mich.

Wanted—General foreman for firm employing 40 men, manufacturing gasolene engines; must have first-class mechanical and execu-

tive ability; no other need apply; state experience, wages and references first letter. Box 862, AMERICAN MACHINIST.

MINNESOTA.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

NEW HAMPSHIRE.

Wanted—A thoroughly reliable and hustling master mechanic or shop foreman who can handle 100 or more good American workmen to best advantage and get out a good production; must be competent designer of tools and jigs for making in duplicate medium automatic machinery accurately and cheaply; conversant with up-to-date machine-shop methods and organization. Address, giving experience, references and salary expected, Box 878, AMERICAN MACHINIST.

NEW JERSEY.

Wanted — Mechanical electrical draftsmen; only first-class men need apply. Box 508, AMERICAN MACHINIST.

Wanted, at once, experienced mechanical draftsmen on electrical machinery; state salary and experience; location near New York. Box 891, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Draftsmen wanted by metallurgical plant between New York and Philadelphia; steel, copper and lead-plant experience desirable, but not essential; applicants must state age, nature of experience and references, and salary to start. Box 844, AMER. MACHINIST.

NEW YORK.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Draftsmen on jigs, fixtures and tools wanted; experienced men only. Mergenthaler Linotype Co., 20-42 Ryerson street, Brooklyn, N. Y.

Toolmakers wanted—Experienced men on punches and dies and general tool work. Steady positions for the right men. Remington Standard Typewriter Factory, Ilion, N. Y.

Wanted—Double-entry bookkeeper, familiar with the iron and steel business; state age, experience, salary, and give references. Address Dilworth, Gilbert & Towne, Inc., 35 Wooster street, New York City.

Draftsmen wanted on details of light wood and steel construction work; accuracy in dimensions essential; good jobs for good men; state age, experience and salary expected. Address Box 899, AMERICAN MACHINIST.

Partner wanted to take active and financial interest; have an agency in London for American tools, established four years; also sole agency U. S. for high speed steel and tools. "High Speed," Box 901, AMERICAN MACH.

Experienced machinist capable of taking charge as foreman of shop employing 40 to 50 hands. Must be capable of handling men, and a good executive. State experience in detail and salary wanted. Box 797, AM. MACH.

Wanted—Expert foreman for manufacturing light machinery; must have executive ability and be able to produce work at minimum cost; state nationality, age, salary, experience and references, or application will not be considered. Box 879, AMER. MACH.

OHIO.

Wanted—High-grade machinists for engine work. S. M. Jones Company, Toledo, Ohio.

Wanted—By the Bickford Drill and Tool Company, Cincinnati, O., experienced toolmakers, vise and scraper hands.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Chief mechanical draftsman, technical graduate, experienced transmission machinery; good permanent prospects with growing concern in Ohio; state definite qualifications and salary expected. Box 802, AMER. MACH.

PENNSYLVANIA.

Wanted—First-class machinists and toolmakers; good wages to right parties; no labor troubles. Box 857, AMERICAN MACHINIST.

Wanted — Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Resident salesman for New York, Boston, Chicago, Philadelphia, Cleveland, Cincinnati and St. Louis, on commission basis, to represent a manufacturing company whose product is special articles in brass and steel, special light machinery, sheet and cast goods. Apply to The General Metals Mfg. Co., Scranton, Pa.

Wanted—A working foreman tinsmith, one who has had experience in the automobile line, who could make hoods, dashes, radiators and other necessities to the automobile in the tinsmith line; one who has held a similar position preferred; must be a hustler and able to earn the highest wages; in answering, state where now employed, giving references, age and experience. Box 892, AMERICAN MACHINIST.

Wanted — By automobile company manufacturing high-class cars, a foreman to take charge of chassis and transmission assembling departments; must have good executive ability, quick at devising rapid and accurate methods of producing results; one now holding such a position preferred, and who can produce the best of references from former employer; state age, where now employed, and in what capacity, also salary expected. All applications will be treated strictly confidential. Address Box 826, AMERICAN MACH.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

VIRGINIA.

Wanted, at once, diesinkers; steady work at 50 cents per hour; also several good trimmer makers. Address P. O. Box 686, Richmond, Va.

WEST VIRGINIA.

Wanted—Foreman for machine shop employing about 15 men on general work; must be energetic and familiar with modern shop practice; state age, experience and salary expected. Location on the Ohio river, about 50 miles south of Pittsburg. Address Box 872, AMERICAN MACHINIST.

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., of Milwaukee, needs more patternmakers, machinists and moulders.

Machinist to construct special iron-working tools; good wages and steady work to the right man. Address Thomas B. Jeffery & Company, Kenosha, Wis. (Rambler automobiles). Kenosha is 52 miles north of Chicago.

Wanted—A few first-class machinists, toolmakers and patternmakers; shop one of the best in the country and equipped throughout with the highest grade of tools; city one of the best in the country; educational facilities of the best; pure water, etc.; only steady, reliable men looking for permanent positions need apply. Address Box 848, AMER. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., are constantly increasing their works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

Foreman—Mechanic for steady employment to act as foreman of an automobile repair department at our factory; ability to rapidly comprehend and to conscientiously carry out instructions more desirable than special knowledge of automobiles; wages depending on ability, but we would prefer one that is worth $30 weekly to one of less earning capacity. Box 825, AMERICAN MACHINIST.

WEST OF MISSISSIPPI.

Wanted—Two blacksmiths and four machine hands on general machine work; steady employment; wages $4 per day of 8 hours; open shop; applicants must state experience fully, as only first-class mechanics will be considered. Box 830, AMERICAN MACHINIST.

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Concrete Construction at the Rambler Automobile Works.

BY JOHN ERWOOD, M. E.*

Although the use of concrete in building construction is well known in the United States, where some fine examples are to be found in railway, office buildings and residence construction; very little use has been made of this highly suitable material in machine-shop walls, although it is true that there are a few scattered factories with concrete walls to be seen throughout the country.

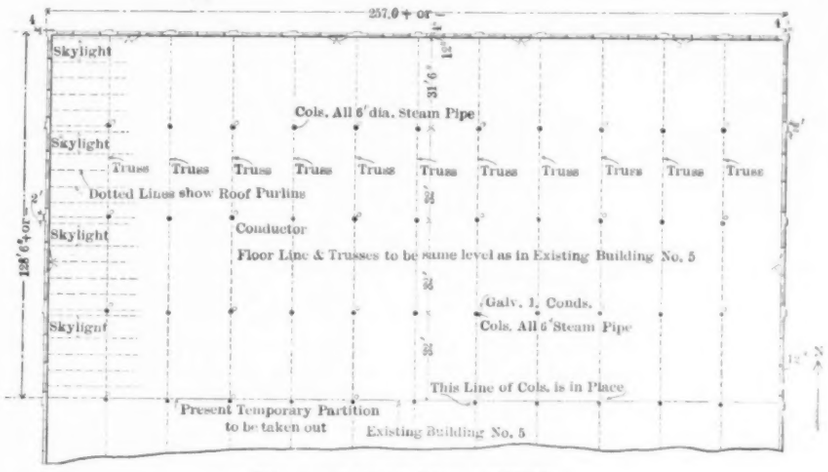

257.0 + or —
Skylight
Cols. All 6' dia. Steam Pipe
Truss
Dotted Lines show Roof Purlins
Conductor
Floor Line & Trusses to be same level as in Existing Building No. 5
Galv. I. Conds.
Cols. All 6' Steam Pipe
This Line of Cols. is in Place
Present Temporary Partition to be taken out
Existing Building No. 5

FIG. 1. PLAN OF UNIT ADDITION.

The Rambler automobile shops, Kenosha, Wisconsin, furnish an excellent example of the use of concrete walls in a carefully worked-out system of saw-tooth roofed, extensible, light machine-shop buildings.

In point of low cost, rapid erection, ready procurability of material, avoidance of fire risk and labor troubles, durability and entire suitableness for the purpose, concrete compares favorably with all of the other factory-wall materials in more common use.

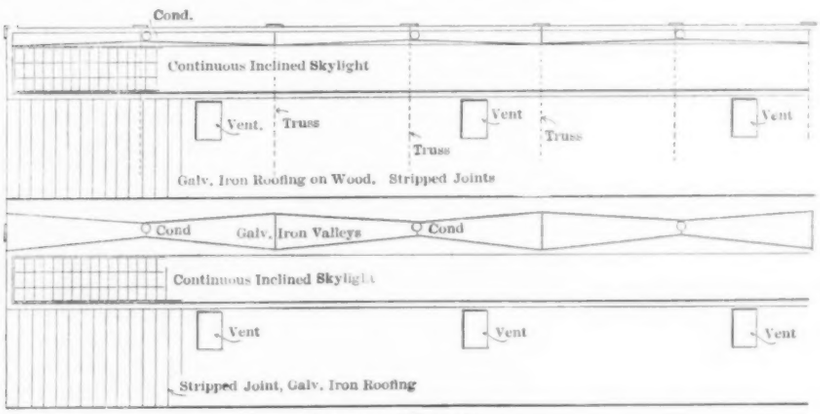


FIG. 2. ROOF PLAN.

The Rambler shops stand on a 33-acre tract of perfectly level ground in Kenosha. Tht original building was the Sterling bicycle factory of brick with parallel lantern roof, 642x101 feet, with some attached buildings, giving at the outset about 90,000 square feet of floor surface. Thomas B. Jeffery began the extensive manufacture of automobiles in 1900, and it was soon seen that a comprehensive plan must be worked out by which continued additions to the factory floor surface could be made in such a manner as to avoid change in existing structures, and obtain continuity of design, general convenience, including perfect lighting and heating, and such a slow-burning construction as to make a large fire loss improbable. This fire prevention is one of the very important requirements of automobile-factory construction, because of the presence of gasolene.

The plans made for the first additions were found, when carried out, to produce highly satisfactory buildings, but were improved in some details, and successive yearly additions have been made until now the Rambler factory has an aggregate area of over 300,000 square feet of roofed floor surface, exclusive of sheds and outhouses. In these Rambler factory additions, cement construction has been employed almost exclusively, some of the buildings using it even for the suspended floors, and it is also used as well for the large fire-service water reservoir, chimney stacks, core ovens and machine and pier foundations, all having their construction materials passed through the mixing machine in the form of plastic cement to finally take shape in molds and become component monolithic details of this large factory-structure assemblage.

The surface of Kenosha is but little above the Lake Michigan level, and the concrete showed to great advantage in the considerable amount of foundation and pier work placed below the water line, where rubble stone could not have been used without inconvenience and added cost, but where concrete was readily and cheaply placed, and has served admirably, no trouble having been had with concrete piers and foundations laid either in dry trenches or submerged.

The Rambler factory demanded first of all large floor areas; the first assembling floor added is 257 feet square. The nature of the operations required the best obtainable lighting, and these necessities led to the selection of the saw-tooth roof, the final north-light construction adopted, which is shown in the drawings, being the result of successive experiments, all successful, but constantly improved up to that here shown.

The connected additions to the Rambler factory have been largely in the form of that shown as Building No. 5, shown in plan in Fig. 1. These buildings comprise a group of three of the dimensions given, 257 feet on each of four sides. The interior construction is 96 truss bents 32x21 feet 4 inches each. The sprinkler and electric-lighting system for each bent is the same, while the posts and truss chords form subdivisions for partition work, making a re-subdividing of each department easy, and greatly facilitating the redistribution of departments which must always follow a considerable floor-area addition to the factory. These are, of course, contingent results which must not be overlooked where continued floor-space additions are expected. In construction the practice was to build in halves, as shown by the illustration, four trusses in length at a time, the open side being temporarily closed against the weather.

Fig. 2 gives the roof plan. The ventilators are let into the south slopes of the roofs, hinged at the bottom and opening about a foot at the top, operated by cords and levers. These south-slope ventilators permit the north lights to be stationary. The valleys have strainer-top spouts, spaced 43 feet centers, from which individual rain and snow water-spouts lead down inside the building to a common main pipe under the floor leading to the reservoir, and thus furnish a considerable volume of desirable water to the two steam

*Of Chicago.

plants. By taking the conductors down inside the building all trouble and annoyance from freezing are avoided.

It is common belief that good concrete can be had only by mixing certain proportions of crushed stone carefully screened to size with a definite amount of cement, but this is not indispensable to wholly satisfactory construction. There is often an abundant supply of suitable gravel close at hand, which may be had more cheaply than crushed stone, and in many instances the material excavated for the foundation will make perfectly good concrete.

For the Rambler buildings, lake-shore gravel was hauled to the plant in wagons, and used under the name of "Lake riprap." This material varied greatly in form, being very coarse in rough weather when the waves ran high, and fine in fair weather when the beach was little disturbed. This varied size of material of course demanded varying quantities of cement mixed with it, but gave no trouble at all, as it was found easy to instruct ordinary laborers so that more or less cement was always added correctly. The use of this lake-shore gravel, at no cost save loading and hauling was highly economical, and had the added advantage of delivering the gravel wherever the gas-engine driven mixer happened to be located, instead of having to unload costly crushed stone from freight cars on wagons and draw it to the mixer. The architect should certainly select the cheapest good materials available, and if his foundation excavation supplies a suitable material for the walls of his building it is folly to go abroad for a costly substitute no better adapted to his purpose.

A great point in favor of using locally obtainable material is found in the ample supply, always at hand, so that when the other conditions are favorable a large extent of wall can be placed in a single day. The common 10 hours work on the walls of these Rambler factory additions was to carry 400 feet of wall 21 inches high; or to lay 45 wagon loads of 1½ cubic yards each in floors or pier and trench work.

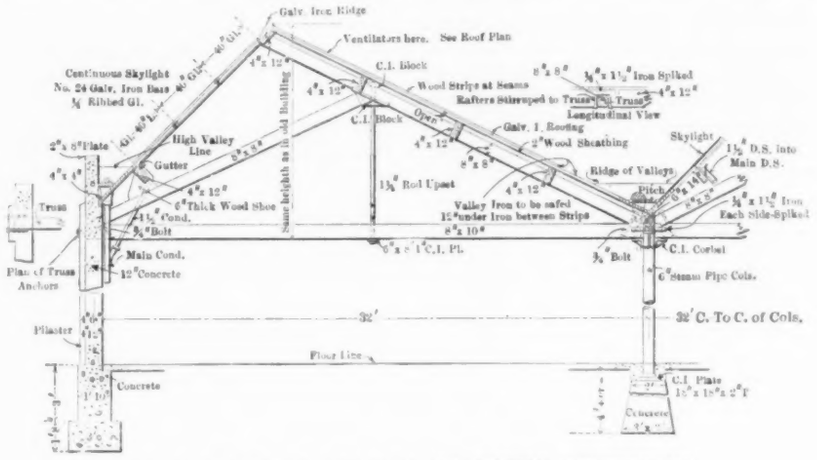


FIG. 3. ROOF TRUSS, SIDE WALL AND COLUMN CONSTRUCTION.

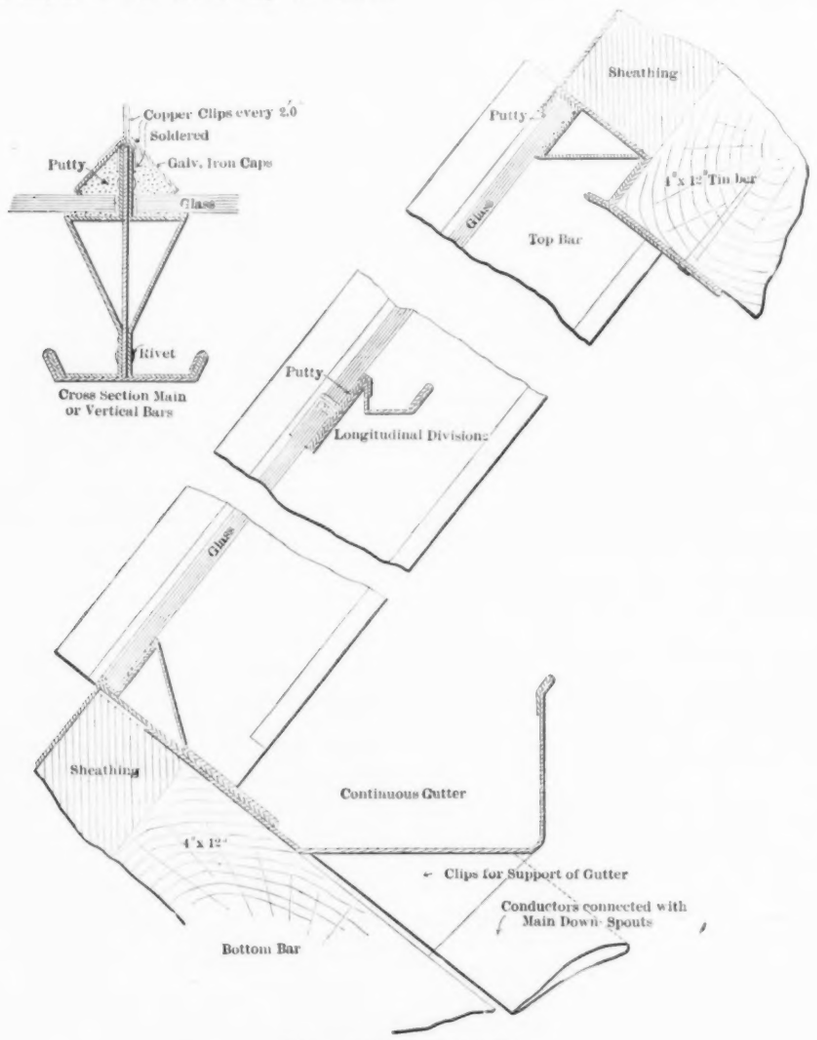


FIG. 4. SKYLIGHT DETAILS.

Fig. 3 gives the truss and wall construction, and a detail of the valley spouting from the roofs. In setting the piers, square taper boxes of wood were made, holes were dug in the ground, the boxes set, and the box tops levelled by the transit. The cement gang followed and filled the boxes, the cement hardening over night enough to permit slipping the boxes off in the morning, ready to use over again. Nearly 270 piers were set this way, using the original 8 boxes to the end. These pier molds were made of common plank planed on the inside only, which was coated with oil to insure easy removal of the mold.

To erect the trusses, one gang of men erected the posts on the piers and secured them in vertical position, and placed the bolsters on the tops of the pillars, ready to take the completed trusses, which were placed, complete, by another gang of men using a cedar post for hoisting. The trusses were made of either Southern or Norway pine, to the drawing as shown.

As will be seen, the trusses are carried on pipe posts. This post was designed by me and is known as the Erwood post. It is a piece of common iron steam pipe, set upon a boss in a sole plate. The truss and lateral girders are set upon the bolster upon three sides and the post is finally filled with liquid concrete purposely mixed fine until it overflows through the core hole at the remaining open side and to facilitate packing it is rammed with a lath. This makes a post of fire-resisting construction, small in diameter and of great carrying capacity. Through the machining

room and hammer shop, these posts carry not only the thrust of the main engine transmission but the truss chords are loaded with lines of shafting hundreds of feet long, and innumerable counter-shafts with belts to the machines below, as well as the heating coils, sprinkler mains, water lines, electric system, air and gas pipes without number, without a single sign of weakness. The detail of the corbel for the posts is sufficiently clear except that it should be said that dowels are passed up into the truss cords and also lag screws to bond the whole mass, up into the trusses from the under side.

The roof boards are of dressed and matched 2x6x12 hemlock, carried on the 4x12 purlins; the outer surface is covered with tar paper with a ½ lap and over this is laid a galvanized-iron roof of standing-joint construction. The joints are spaced on 2-inch wood strips with overhanging seams permitting of ample expansion, as shown. The glass used is of the common ribbed variety, ¼ inch thick, in 18x40-inch panes three deep in metal sash drained from the under side, as shown, into the rain spouts. A full detail of the sash bars and method of puttying and guttering is shown in Fig. 4 and is self explanatory. This system of drainage permits the inside face of the glass to be swabbed off without excessive drip to the floor below. The window work in the side walls is of the same glass, the two lower and larger lights being fixed and the two upper or smaller ones being hung from the bottom and operated with common transom lifts. The frames are of common dressed plank, set in the concrete forms and held in the concrete, making a tight wind joint between frame and wall. All of the frames for doors and windows were painted before setting to prevent swelling and ultimate shrinkage. The roofing iron was also painted on the under side with non-corrosive paint and all valley seams were heavily soldered.

In the machine shops the iron posts carry the shafting with the addition of an intermediate hanger. Most boxes are held to the compound iron post on a saddle fixed by means of post straps. The intermediate hanger and all counter-shafts are suspended from the truss cords by means of 3x12 purlins held in stirrups from truss to truss.

While the general span of all the trusses is shown at 32 feet, two buildings have saw-tooth spans of 40-feet centers carrying skylights four panes of glass deep. In the construction of these roofs nearly 100,000 feet of glass was used, equivalent to almost 2½ acres, while the saw-tooth spans if placed end to end would make a double-track train shed 1¼ miles long. These figures will give some idea of the growth of the automobile industry in this country, practically in its infancy and suggestive of its limitless scope.

The Design of an All Gear Headstock.

BY H. T. MILLAR.

At page 808, Vol. 28, Part 2, different types of change-gear motions were described, including one, Fig. 7, which is thought to have several distinct advantages. The motion, it may be remembered, consists primarily of three sets of three wheels mounted on parallel shafts, the two outer sets movable along shafts to permit any wheel in the set to mesh with its mate on the central shaft. The driven shaft has therefore nine speeds. It is here intended to show the motion in a further stage of development, the accompanying drawings explaining the construction suitable for a headstock of 8-inch centers (16-inch swing) or thereabouts. The reversing motion has not been shown, as it does not affect the subject of this article.

Position of Handles M and N																
Single Speed	296	202	165	132	114	90	72.8	61		39.5						
Spindle Speeds Double Gear									49.5		33.6	27.5	22	19	15	12.13	10.2	6.6
Speeds in Geometric Ratio	245	198	165	135	110	91	73.5	60.25	49.4	40.6	33.5	27.2	22.2	18	14.8	12.18	10	8
Error	21%	4%	—	2%	4%	1%	1%	1%	—	3%	—	1%	1%	5.5%	1%	—	2%	17%
Driving Pulley 230 Revs. per Min.																		

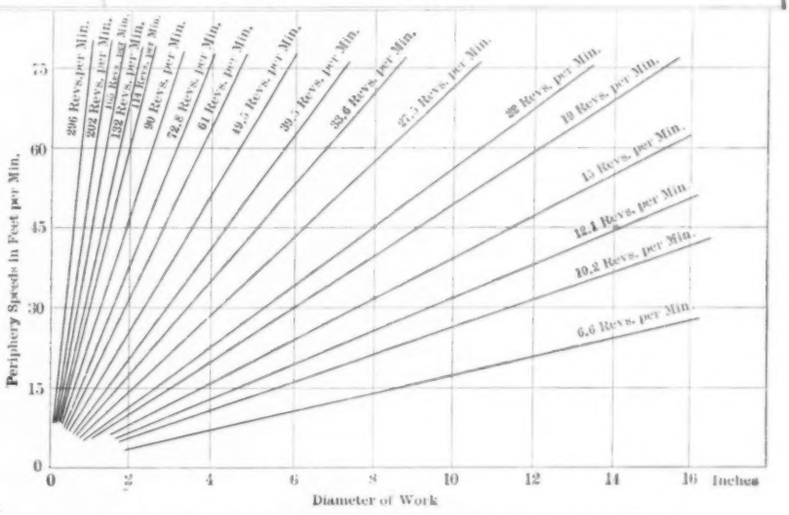


FIG. 1. PERCENTAGE OF ERROR AND PERIPHERAL SPEEDS OF WORK.

As explained in the previous article, it is not possible to arrange the speeds resulting from this motion in strict geometric progression, but the gears can be so proportioned as to bring the speeds quite within the limit for practical work. In Fig. 1 is given the spindle speeds for this headstock and their percentage error. It will be seen that half the speeds are within 2 per cent., and, with the exception of the two extremes, all lie within that error which in a cone pulley drive results from the varying slip of the belt when running over the different diameters of a cone pulley. The error in the highest and lowest speeds is not thought to be very serious. It gives a higher speed for polishing and lower speed to special work than would ordinarily be obtained without destroying the small rise between the general bulk of the speeds. The diagram of Fig. 1 shows the peripheral speeds of different diameters for each spindle speed.

The power the headstock is to be capable of transmitting to the driven plate is of course dependent upon the cut to be taken by the lathe and the material it is to be taken from. As it will govern the dimensions, if not the design of the headstock, it must be decided at the start. Dr. Nicholson divides lathes into three general classes—carbon lathes, which are the ordinary old-style lathes; high-speed lathes, and composite lathes. To the latter class, however, belong most of the lathes advertised and sold as high-speed.

According to Dr. Nicholson an ordinary carbon lathe of 8-inch centers should be capable of delivering about one and a half horse-power to the tool, a composite lathe five horse-power and a high-speed lathe 10 horse-power. This is greatly in excess of the strength of the majority of high-speed lathes of this size. It was decided to design this headstock for a composite lathe, and working at the maximum capacity it should be capable of taking a cut ¼ inch deep by 1/10 inch traverse in mild steel at 40 feet per minute.

The driving pulley *P* is mounted loosely on shaft *W*, Fig. 2, and is clutched to it by friction plate *V* which is moved by

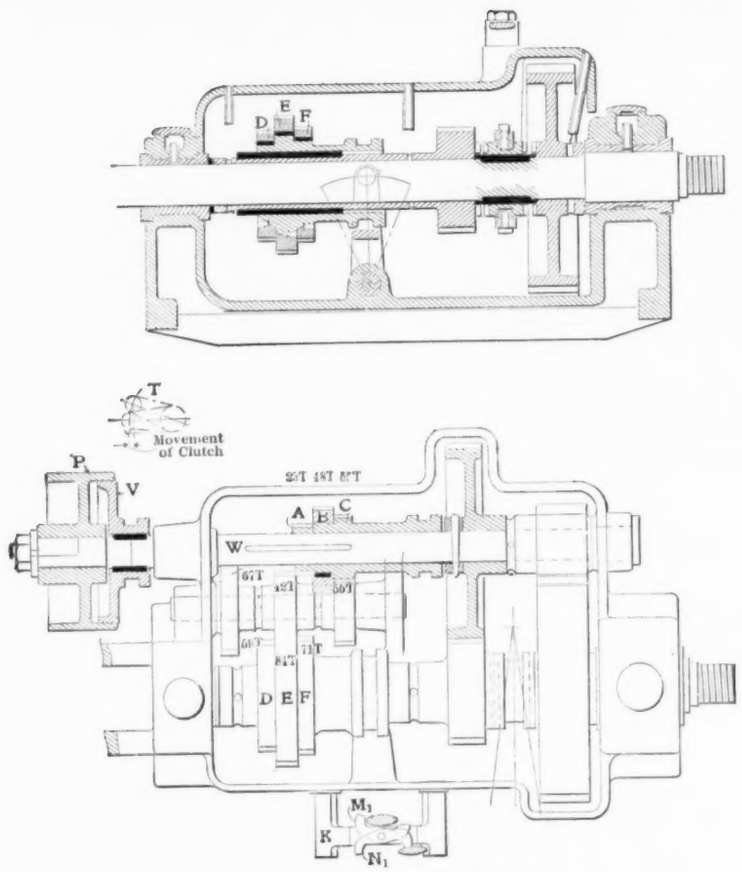
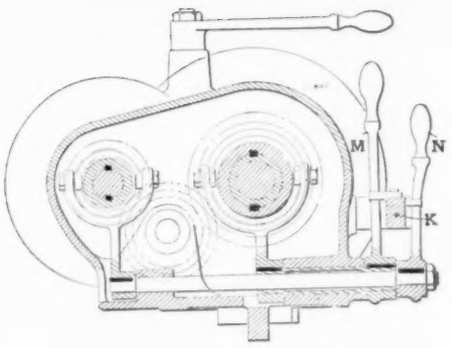


FIG. 2. SECTIONS OF HEADSTOCK.

handle lever U and the small lever T. As the lever T approaches parallelism with the shaft, the leverage obtained is tremendous. In consideration of the fact that the driving pulley is not large in diameter the width of the belt was calculated for an effective tension of 45 pounds per inch width. For a headstock of this type the average effective belt tension required would not be more than half this. So 45 pounds per inch width should not be unduly high.

As will plainly be seen from Fig. 2, gears $A\,B\,C$ on the driving shaft and $D\,E\,F$ on the spindle sleeve are actuated by handle levers M and N, M being keyed on a hollow shaft through which the shaft for N passes. In order that the gears may be snapped quickly into mesh it is desirable that the ends of the teeth should be rounded in a similar manner to the change gears for automobiles and also that the handles M and N should have some positive stop when the wheels are in full mesh. These are provided by the ends of the bracket K for the outer gears and by the double-ended catches M and N for the center wheels. Fig. 4 shows the action of these catches better than any number of words would do it. No intermediate positions have been provided for the levers. It is intended to change rapidly from one speed to another, thereby preventing the driven wheels losing much momentum.

All the nine wheels in this set are of mild steel, case-hardened, and in calculating their proportions the safe fiber stress was assumed at 25,000 pounds. The widths of the wheels on the driving shaft need not be quite so large as those on the spindle sleeve, but the difference is slight and as nothing would be gained by making them less, the widths have been determined by the corresponding wheels on the spindle sleeve.



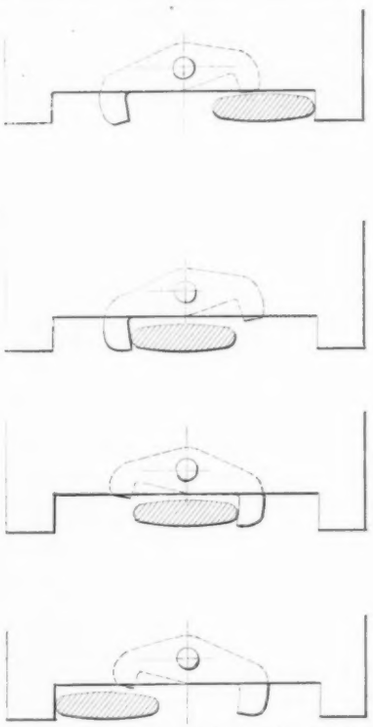
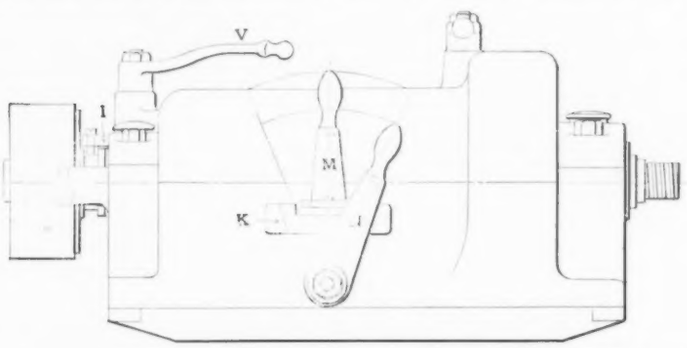


FIG. 4. ACTION OF CATCHES FOR CHANGE LEVERS.

It will be noticed that all the handles have been brought close together. The headstock can be stopped or started and all speed changes made from a convenient position in front.



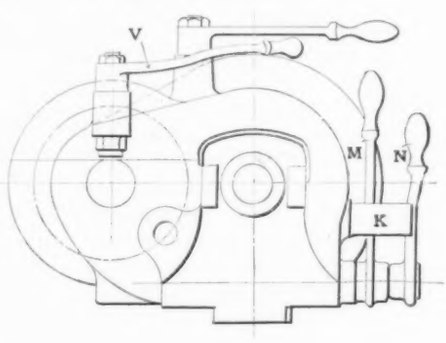


FIG. 3. ELEVATIONS OF HEADSTOCK.

Another matter of some moment is the small number of gears in mesh at any time. Including the back gears eight is the maximum, sometimes only seven; when running single gear four of these revolve idly. All of them are under load when working through the back gear. The advantage in keeping the number of gears running under load small is generally recognized, but in many change-speed motions there are a number of idle gears running in mesh. These, besides absorbing power, are a fruitful source of noise, as a pair of gears make a great deal more noise when running idly than when under load.

Manchester, England.

Strength of Steel at Low Temperatures.

Testing steel at extremely low temperatures was done during the past year at the Watertown arsenal in Massachusetts. After the specimens had been placed in a tensile-testing machine they were cooled in a bath of liquid air, and the resulting contraction of the metal measured by an extensometer, the increase of stress being recorded on the weighing bar of the testing machine. The steels tested varied in quality from 0.16 to 1.09 per cent. carbon, but the amount of contraction in the different specimens was substantially the same, the range being from 0.00177 to 0.00191 inch per linear inch of the specimen. An initial stress of 4000 pounds per square inch on one of the bars was increased to 26,800 pounds per square inch by the contraction of the specimen due to the cooling by the liquid air bath; the elastic limit of this steel was 80,000 pounds per square inch, with an elongation of 10.7 per cent. at the low temperature of the liquid air. A similar specimen tested at a room temperature of 76 degrees F. showed an elastic limit of 52,800 pounds per square inch, an elongation of 29.3 per cent., the effect of the very low temperature being to increase the elastic limit of the steel 51 per cent., while the ultimate strength of the steel was raised to 97,600 pounds per square inch, or 35 per cent. above the ultimate strength at ordinary temperatures. The results of these experiments are similar to those that have been obtained by numerous other experimenters who have investigated the properties of steel under the same conditions, in that it is shown that a great increase is produced in the tensile strength of steel at low temperatures, with a corresponding decrease in ductility.—*Engineering Record.*

The Utah Copper Company has recently placed with the Risdon Iron Works, of San Francisco, an order for nearly twelve hundred concentrators, which is believed to be the largest order ever placed. Incidentally the transaction shows that there is something doing in the earthquake-stricken city.

On the Raising of Water by Compressed Air, at Preesall, Lancashire.*

BY JAMES KELLY.

The experiments described in the following paper were carried out at the works of the United Alkali Company, Limited, at Preesall, where large quantities of water for steam-raising and other purposes, in connection with the manufacture of heavy chemicals, are raised from wells by means of compressed air. The present requirements amount to 200,000 gallons per 24 hours.

Description of the Installation at Preesall—The water-bearing strata are the New Red Sandstone beds, which in this district are found at a depth of 80 feet to 100 feet from the surface, the over-lying strata being red marl, sand and gravel, clay, and loamy soil, in ascending order. In the early days of the company's operations in this district, sufficient water to meet its requirements was obtained by sinking wells into the gravel, but as the business developed and more water was required, two wells were sunk into the red sandstone, and were fitted with lifting-buckets and the necessary engines, etc. The cost of maintenance of this plant was very high, due, doubtless, to some extent, to the pumps being forced in order to cope with the increasing demand for water, but chiefly to sand in the water cutting up the buckets, valves and working-barrels. Having regard to this, and other peculiar circumstances of the case, namely, the necessity of raising water over a considerable area, owing to the low yield from any one well, and the desirability of having some system free from any great liability to stoppage or breakdown, it was decided to adopt the compressed-air method for the next well sunk. This well, No. 17, is 450 feet in depth and 12 inches in diameter at the bottom, and is fitted, as shown in Fig. 2, with a lining-tube going down to the rock-head, and an air-tube 6 inches in diameter, with a delivery-tube 4 inches in diameter inside it, the effective cross-sectional area of the air-tube being thus the area of the annulus formed between it and the delivery-tube. For working this well a small Ingersoll-Sergeant air-compressor, brought from one of the company's other works, was modified to suit the conditions of work at Preesall. The machine is compounded for air, but not for steam; the air-cylinders are water-jacketed, but there is no inter-cooling, and the volumetric efficiency is consequently not very high.

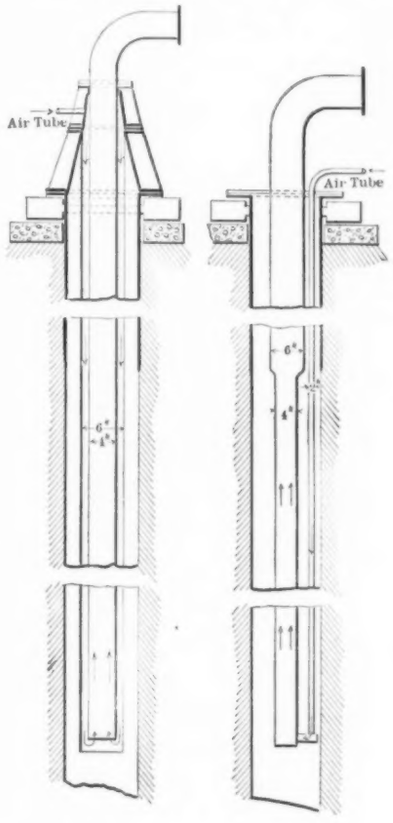


FIG. 1. WELLS NOS. 17, 38 AND 39.

FIG. 2. WELL NO. 40.

The results of some preliminary working of the system were considered so promising that the installation of a larger plant capable of fulfilling all the requirements of the works was decided upon. There are now four wells equipped for raising water by compressed air; these are numbered 17, 38, 39 and 40. Particulars of the dimensions of the wells, and their distances from the compressor, are given in the table. The air-pipes have been designed to reduce loss by leakage or friction as much as possible, and the water flowing from the wells descends by gravity to a small brick reservoir. The arrangement of the pipes in wells Nos. 38 and 39 is similar to that in No. 17, Fig. 1, but in well No. 40 the delivery- and air-pipes are arranged on a different plan. In this case the air-pipe passes down the well outside the delivery-pipe and is connected to it at the bottom, as shown in Fig. 2. A new air-compressing plant was installed, consisting of an Ingersoll-Sergeant cross-compound air-compressor, having both the air- and the steam-cylinders compounded. The speed is regulated by a governor in the usual manner, and also by the pressure of the air as it leaves the high-pressure air-cylinder. The air-cylinders are water-jacketed, and the air from the low-pressure air-cylinder is delivered to an inter-cooler, from which it passes to the high-pressure air-cylinder. The air suction-valves are carried on the piston, the air passing into the piston through a hollow tail-rod working through a stuffing-box and gland on the end of the cylinder, and the delivery-valves are controlled by suitable spiral-springs. The steam-cylinders are 20 inches and 32 inches in diameter, and the air-cylinders

*Abstracted from a paper read before the Institution of Civil Engineers.

28.25 inches and 16.75 inches in diameter, the stroke being 24 inches. The percentage of clearance in the air-cylinders is very small. The air is compressed to 35 pounds per square inch in the low-pressure cylinder and in the high-pressure cylinder to a pressure ranging between 80 and 120 pounds per square inch, according to the depth of submersion of the delivery-pipes in the well or wells under operation. The machine is rated very much higher than the present requirements, so that, should a greater quantity of water be required at some future time, more wells can be sunk and operated from the same station. The small compressor first installed is kept as a spare machine, and could be utilized in the event of the larger machine breaking down, but such a contingency has not occurred during 2½ years' working.

The small brickwork reservoir already referred to, in which the water raised from the wells is collected, is divided into two equal compartments by a wall which is lower in the middle than at the sides, Fig. 3. The water flows into one compartment of the reservoir, where the sand in it is allowed to settle; it then flows over the weir formed in the center of the midwall, into the other compartment, which contains the suction-pipes of the force-pumps employed for raising the water to the works-reservoir, more than a mile away. From this reservoir the water is distributed to the different works at which it is required. A notable feature of the distribution is the carrying of the larger portion of the water across the estuary of the river Wyre, a total distance between the reservoir and the works of about 3 miles. At the point of crossing, the river Wyre is nearly 2 miles in width at high-water; at low-water the width is much less, and the difficulty of carrying the water-pipes across the estuary arises from the fact that a portion of the channel consists of shifting sand. The difficulty has been met by laying the water-pipes on both banks as far as the ground is firm, and securely fixing the ends to piles, these ends being then connected by means of a strong specially constructed armored hose. This arrangement has proved very successful, and the armored hose has been found more satisfactory than flexible copper tubing, which was first tried.

Experiments at Preesall—In making the experiments, the water raised was measured in the small brickwork reservoir, Fig. 3. The compartment containing the suction-pipes of the force-pumps having been pumped nearly empty, the force-pumps were stopped. The reservoir was then allowed to fill up to a given level with water from the air-lift, the time occupied in the operation being noted. Meanwhile the level of the water in the well had been determined, in order to ascertain the "lift," or hight of delivery. In the engine-room, indicator-diagrams were taken from the steam- and air-cylinders, the speed of the compressor was registered by means of a stroke-counter, and the air-pressure was read off from the gage. Thus all the data necessary for calculating the results were obtained. Each set of results tabulated is the mean of two, and in some cases three, sets of concordant observations.

The first series of experiments was made in January, 1903, on well No. 17. At that time the delivery-pipe of this well was carried 40 feet above the surface of the ground, the original intention having been to run the water by gravitation to the works-reservoir directly, instead of employing intermediate force-pumps as at present. The total length of the delivery-pipe was 433 feet. With the compressor working at speeds ranging between 17 revolutions per minute and 29.6 revolutions per minute, the number of gallons of water raised per minute was practically the same at all rates of working; that, as the rate of working was increased the volume

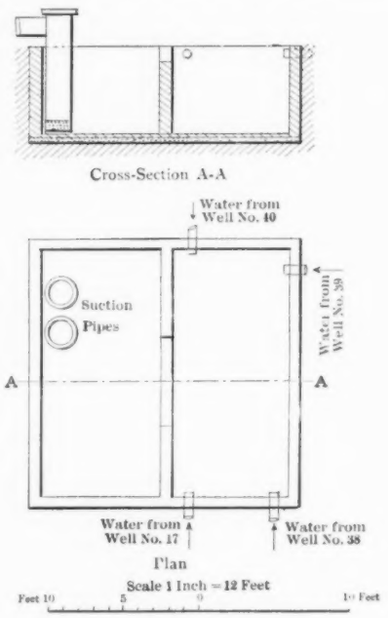


FIG. 3. PLAN OF MEASURING TANK.

of air used per cubic foot of water raised increased very rapidly, and the efficiency fell off at a proportionately rapid rate. This set of experiments indicated the futility of forcing the output of a well, and also that the series had been started at too high a rate of working, and that increased efficiency might be obtained at lower rates of working. In order to obtain, if possible, a higher efficiency, the 40-foot length of delivery-pipe projecting above the surface of the ground was removed and a 60-foot length was taken out of the well, reducing the length of the delivery-tube to 323.5 feet. This made the ratio of hight of delivery to "dip" (i.e. depth of submersion) approximately equal to that recommended by Professor Josse, namely 1:1.5. Another series of experiments was then made, the small compressor being used for the first two sets of experiments in order to obtain a lower rate of working, and the large compressor for the remaining four sets. The highest efficiency* obtained in this series of experiments was 24 per cent., which, although still low, was a decided improvement on the results obtained in the first series.

It will be observed, however, that the highest efficiency was obtained at the lowest rate of working, and that the volume of free air used per cubic foot of water raised was still very much higher than the volume (3 to 5 cubic feet) stated by Mr. Rix to be necessary for wells of this depth of submersion and lift.

The next series of experiments was made in April, 1903, on well No. 38. This well is 350 feet in depth and of the same diameter as No. 17. It has, however, larger pipes fitted into it, the delivery-pipe being 5 inches and the air-pipe 7 inches in diameter. The air-pipe has thus an effective area of 18.75 square inches. In the first four experiments the delivery-pipe was 309.5 feet in length, and on working out the results it was found that the ratio of dip to hight of delivery was approximately 1 : 1. This was altered by adding a 30-foot length to the delivery-pipe, after which two more experiments were made.

If these experiments be compared, it is at once apparent that the lengthening of the delivery-pipe has had a marked effect on the efficiency, the efficiency in experiment No. 1 being 29.3 per cent. and in experiment No. 5, 34.3 per cent., the same proportionate difference being observed between experiments Nos. 2 and 6, indicating the importance of the ratio of dip to hight of delivery being kept nearly equal to 1.5 : 1. The best feature of this series of experiments was the increase in the efficiency to 34.3 per cent.

If the results obtained from wells Nos. 17 and 38 be compared, it is seen that the increase in the cross-sectional area of the pipes has had a greater effect than that observed by Professor Josse. He found on increasing the area of the delivery-pipe by 20 per cent. that the efficiency only increased by 1.3 per cent. The difference in area of the delivery-pipes in these two wells is about 33 per cent., and the efficiency has increased from 24.3 per cent. to 34.3 per cent.

Well No. 39 was next put in operation. This well is fitted with the same size of pipes as No. 17. A series of experiments at comparative rates of working was carried out on wells Nos. 38 and 39. The rate of working well No. 38 varied between 14.3 and 32.4 revolutions of the compressor per minute, and the efficiency between 38.6 per cent. and 23.4 per cent., the free air used per cubic foot of water raised varying between 3.8 and 7.16 cubic feet. With well No. 39 the rate of working varied between 13.5 and 30.5 revolutions per minute, and the efficiency between

*The efficiencies given in this paper, except where otherwise stated represent the ratio of the work done in raising water to the work indicated in the air-cylinders of the compressor.

30.4 per cent. and 14.9 per cent., while the free air used varied between 5.77 and 11.83 cubic feet per cubic foot of water raised. There are two possible explanations of the difference in efficiency of these wells, namely: (1), the difference in cross-sectional area of the air- and delivery-pipes; and (2), the difference in length of the delivery-pipes. In order to ascertain whether the difference in length was the cause of the low efficiency, a series of experiments was made on well No. 39, after reducing the length of the delivery-tube by 34 feet. If these are compared with those made on the long pipe it will be seen that shortening the delivery-pipe has had no beneficial effect on any of the factors governing the efficiency, and the conclusion seems justifiable that the larger area of the pipes in well No. 38 is the principal

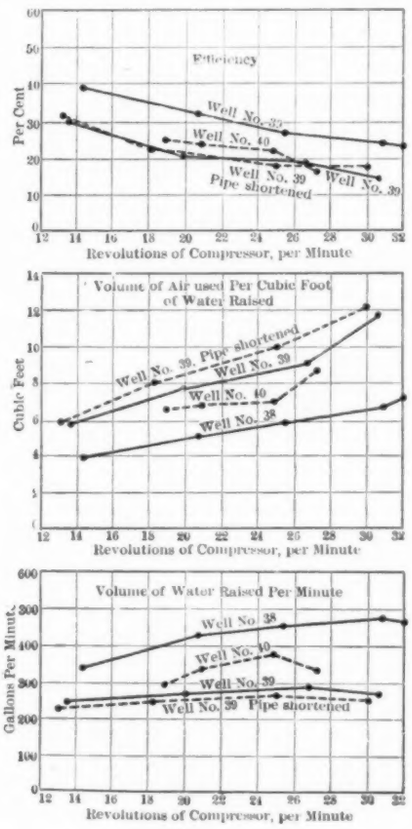


FIG. 4.

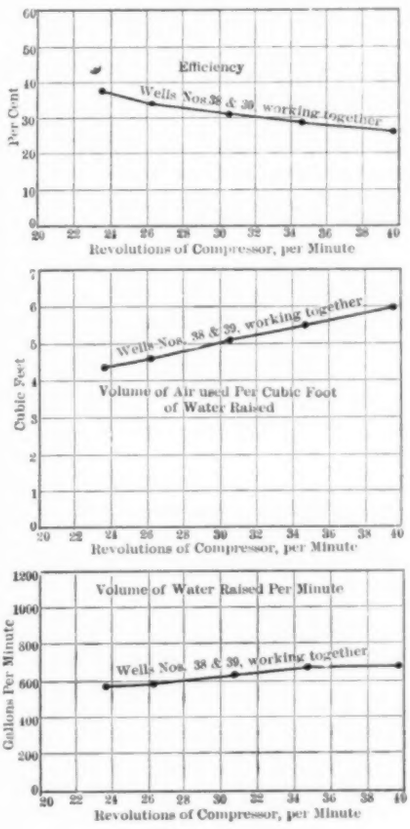

Efficiency
Per Cent
Wells Nos. 38 & 39, working together
Revolutions of Compressor, per Minute
Wells Nos. 38 & 39, working together.
Volume of Air used Per Cubic Foot of Water Raised
Cubic Feet
Revolutions of Compressor, per Minute
Volume of Water Raised Per Minute
Gallons Per Minute
Wells Nos. 38 & 39, working together
Revolutions of Compressor, per Minute

FIG. 5.

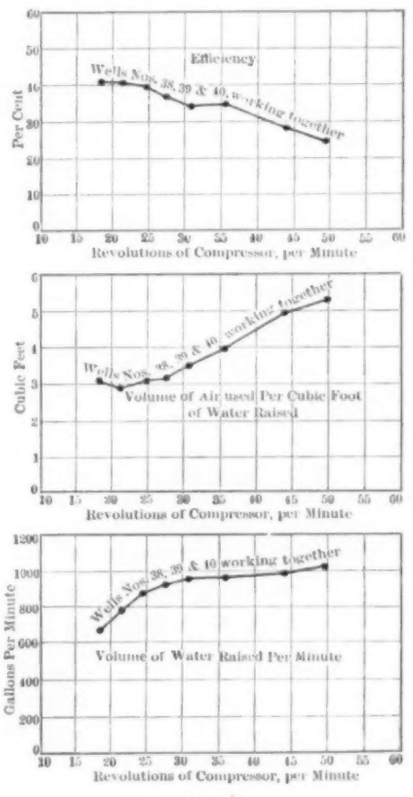

Efficiency
Per Cent
Wells Nos. 38, 39 & 40, working together
Revolutions of Compressor, per Minute
Wells Nos. 38, 39 & 40, working together
Volume of Air used Per Cubic Foot of Water Raised
Cubic Feet
Revolutions of Compressor, per Minute
Wells Nos. 38, 39 & 40 working together
Volume of Water Raised Per Minute
Gallons Per Minute
Revolutions of Compressor, per Minute

FIG. 6.

factor in determining its superiority over the others, and that for wells of this depth a pipe 5 inches in diameter is preferable to one of less diameter.

The diagrams in Fig. 4 have been plotted from the data obtained from wells Nos. 38, 39 and 40, and show graphically the efficiency, the volume of free air used per cubic foot of water raised, and the number of gallons of water raised per minute, from each of the wells, at various rates of working. A comparison of the curves for the different wells shows the superiority of the results obtained from well No. 38.

The next series of experiments was made on wells Nos. 38 and 39 working together. These experiments were undertaken in order to determine the best conditions of working for raising volumes of water up to 40,000 gallons per hour. Some difficulty was experienced, at the beginning of the experiments, in regulating the supply of air to each well, so that they should yield a proportionate amount of water, in accordance with the results of the previous experiments. This could not be done accurately, as there was no means of measuring the flow from each well separately. The best that could be done was to approximate to the correct amounts by observing the flow from the pipes into the brickwork reservoir. The rate of working varied between 23.7 revolutions and 39.8 revolutions of the compressor per minute.

RESULTS OF THE EXPERIMENTS.

At the lower rate of working an efficiency of 36.8 per cent. was attained, the quantity of water raised being 34,200 gallons per hour; at the higher rate of working the efficiency had fallen to 26.7 per cent., the quantity of water raised being 40,300 gallons per hour; thus, by increasing the rate of working by 68 per cent., the quantity of water raised only increased by 12 per cent. Had this series of experiments been made for the purpose of finding the highest efficiency, without regard to the quantity of water raised, the rate of working should have been lower at the commencement, when doubtless the efficiency would have been higher. The results of this series of experiments are represented graphically in Fig. 5. An examination of the curves shows the same fall in efficiency, rise in volume of free air used, and slow rise of the quantity of water raised, with a tendency to decrease after the rate of working reaches a certain point, as was observed in the case of the separate wells.

A series of experiments on working three wells together presented the same difficulty as was experienced when working two wells together, and to obtain a proportionate flow from each well the same artifice had to be adopted. The object of the experiments was to find the efficiency when raising about 40,000 gallons of water per hour. A speed of 20 to 22 revolutions per minute was found to yield this quantity of water, and two experiments were made at about this rate of working. The rates of working are so nearly equal that the average would perhaps give the truest values; but it is interesting to note in this case, as in the others, that the highest efficiency was attained at the lower rate of working.

During the month of May, 1904, well No. 40 having been started, a series of experiments was made with it for comparison with the others. As already mentioned, this well differs from the others in the arrangement of the pipes, and in its comparatively greater distance from the compressor. The arrangement of the delivery- and air-pipes in this well is illustrated in Fig. 2. The air-pipe is 2 inches in diameter and passes down the outside

of the delivery-pipe. The lower part of the delivery-pipe is 4 inches in diameter, but the upper portion, for 100 feet from the surface, is 6 inches in diameter. This enlarged pipe was put in with the object of reducing the velocity of the air and water as they approached the surface, in the hope of increasing the efficiency of working. In transmitting the air to this well a fall of 3 pounds per square inch in the pressure was observed, due to the greater distance from the compressor. Comparison of these results with those from wells Nos. 38 and 39 show that they are somewhat better than those from well No. 39, but very much worse than those from well No. 38. The results are plotted alongside those for wells Nos. 38 and 39 in Fig. 4, which show at a glance the relative value of the results in each case. The effect of the alteration in the arrangement of the pipes in this well appears to be beneficial, and it seems probable that had a larger delivery-pipe been used, the results would have been at least as high as those obtained from well No. 38.

The next series of experiments was made in June, 1904; wells Nos. 38, 39 and 40 were worked together, and the air-supply was regulated as before, so that each well gave a proportionate flow. The object of the experiments was to determine the efficiency of the system between a minimum and a maximum rate of working. The minimum rate at which the three wells could be kept running was found to be about 18 revolutions of the compressor per minute. The maximum rate at which it was considered safe to run the compressor was 50 revolutions per minute. The highest efficiency obtained, 41.2 per cent., was again obtained at the lowest rate of working, the free air used being 3.01 cubic feet per cubic foot of water raised, the water raised being 38,160 gallons per hour. At the highest rate of working the efficiency had fallen to 24.6 per cent., the volume of air used had risen to 5.22 cubic feet per cubic foot of water raised, and the water delivered was 60,000 gallons per hour. The results are plotted in Fig. 6, the most noteworthy feature of which is the rapid rise of the curve for the quantity of water, at the beginning of the series of experiments, and its very gradual rise toward the end of the series. Had it been found practicable to continue the experiments further, it appears probable that the curve would ultimately have shown a tendency to descend, as in the case of the single wells when the higher rates of working were attained.

In order to ascertain whether the action of the compressed air in an air-lift is similar to that of a piston in a cylinder, or whether the air forms an emulsion with the water, a series of observations and experiments were made on well No. 38, using the small compressor so that a very low rate of working could be attained. The results appeared to show that the air might act in either way, or by a combination of both, depending upon the rate of working. With a very low rate of working, air passed through the well without lifting the water high enough to overflow. As the rate of working was increased, water began to flow intermittently and in cycles. The water would begin to run slowly, the flow gradually increasing until the delivery-pipe was running full; then there would be a rush of air, causing the water to rise in the form of a dense spray, after which the flow would gradually diminish, and finally stop. If the rate of working was kept constant the flow continued in periodic cycles. The series of experiments was commenced at 82 revolutions of the compressor per minute, and the rate of working was increased by 20 revolutions per minute at a time, until a speed of 165 revolutions per minute was attained. In experiment No. 1 the cyclic period was 2 minutes 20 seconds, during 1½ minutes of which no water flowed from the well. During the remaining 50 seconds, the flow, commencing slowly, gradually increased until the rush of water and air already referred to took place, after which the flow gradually declined until it ceased altogether. In experiment No. 2 the cycle occupied 2 minutes, water flowing for 1¼ minutes, and no flow taking place during the remaining ¾ minute. In experiment No. 3 the period was 1¼ minutes, the stoppage in the flow lasting only ¼ minute. In experiment No. 4 the flow was continuous, but varied in volume from time to time. In these four experiments the action of the air appeared to be similar to that of a piston. In experiment No. 5 the flow of water and air was continuous, and resembled a dense spray, the air appearing to form an emulsion with the water.

The results of the foregoing experiments indicate that there is a certain rate of working wells by compressed air at which the maximum efficiency is obtained, and that the best efficiencies are obtained at comparatively low rates of working. Previous experimenters are agreed on the necessity of keeping the velocity of the water in the pipes low, and fix the limits of this velocity at 4 to 8 feet per second; but from the author's experiments it would appear to be necessary to take into account the combined volume of both air and water in fixing a limit of velocity in the pipes.* Where the highest results have been obtained the velocity of the air and water combined has been about 12 feet per second at the point of entering the delivery-pipe. As the air and water rise to the surface, the velocity continually increases, due to the increasing volume of the expanding air. Having regard to this circumstance, it has been suggested that the delivery-pipe should gradually increase in diameter from the bottom of the well to the surface. An approximation to this arrangement is that adopted in well No. 40, Fig. 2. A comparison of the velocity at the top of the delivery-pipe in this well with that in either of the wells Nos. 38 and 39 shows that the velocity at the top was much reduced by increasing the diameter of the delivery-pipe. What effect this had on the efficiency cannot be determined, owing to other disturbing factors. If this point could be investigated under truly comparative conditions, the results no doubt would prove interesting.

The cost of raising the water from the wells by compressed air, and to the works-reservoir by the force-pumps, is 1d. per 1,000 gallons, including cost of labor, fuel at 12s. 6d. per ton, stores and maintenance. The total lift may be taken as 160 feet on an average, so that the cost per 1,000 gallons raised 100 feet is 0.625d. From the information gained from these experiments, together with alterations in the steam-generating plant, a considerable reduction of this cost is anticipated.

It has not been found possible to determine directly what fraction of the cost should be assigned to the compressed-air plant, but an approximation to the cost for fuel may be arrived at in the following manner. In a steam-consumption test of 8 hours' duration, the compressor was found to take 29 pounds of steam per i.h.p.-hour at a pressure of 90 pounds per square inch, the rate of working being such as would give 40,000 gallons of water per hour from three wells working together. In experiment No. 1, 30,000 gallons of water were raised 100 feet, approximately, for an expenditure of power equal to 51 i.h.p.-hours. Assuming the steam-plant to be capable of generating 29 pounds of steam with 4 pounds of fuel, then 38,000 gallons of water could be raised 100 feet for 204 pounds of fuel, which, with fuel at 12s. 6d. per ton, gives a cost of 0.36d. per 1,000 gallons lifted 100 feet. Before the compressed-air plant was installed, the total cost of raising water by the lift-pumps was 0.9d. per 1000 gallons delivered to the works, or 0.562d. per 1,000

Number of Well.	Depth.	Diameter.	Area of Delivery.	Effective Area of Air-Tube.	Depth of Delivery.	Distance from Compressor.
	Feet.	Inches.	Sq. Ins.	Sq. Ins.	Feet	Feet.
17	450	12	12.56	16.2	323.5	600
38	350	12	19.63	18.75	339.5	600
39	350	12	12.56	16.2	347.0	825
40	350	12	12.56	3.1416	326.5	5,400

PARTICULARS OF AIR-LIFTS AT PREESALL.

*Obtained by calculating the volume of the air used per minute at the pressure at which it enters or leaves the delivery pipe, adding this to the volume of water raised per minute and finding the velocity with which the mixture must pass through the pipe in order to deliver the combined volume in one minute, assuming this volume to remain constant during the operation.

gallons lifted 100 feet. The lift-pumps were believed at that time to be giving an efficiency of 80 per cent., but this is probably much too high; in a recent test they gave only 58½ per cent. efficiency, but under more favorable conditions the efficiency would probably have been about 65 per cent. Experience of the working of these air-lifts has amply justified the installation of the system, since the extra cost for fuel is nearly balanced by the saving in maintenance-costs alone, leaving out of account the saving due to freedom from stoppages, and the interest on the cost of extra plant which would have been required had the system of lift-pumps been extended to meet the present and future requirements.

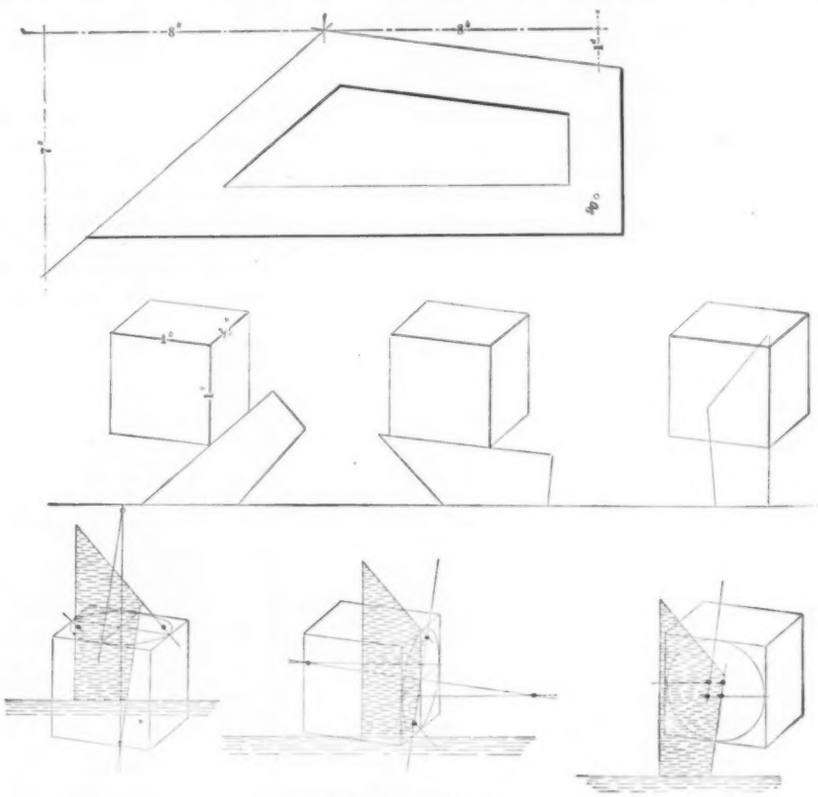
The author desires to express his indebtedness to the United Alkali Company, Ltd., of Liverpool, for permission to publish the results of the experiments described in this paper; and to their chief engineer and his staff for assistance in carrying out the experiments.

Dimetric Projections.

BY PETER PALMER.

Everybody is familiar with isometric drawing as an easy and effective method of producing approximate perspective views, especially in cases when the object to be represented does not exist in reality but is given, perhaps, by working drawings in ordinary rectangular projection. The facts that in isometric drawing all the straight lines are measured by the same scale, and that the ordinary 30-degree triangle is used are undeniable advantages of the method. On the other hand it will be admitted that isometric views always look awkward and unnatural. Views that appear to the observer much closer approximations of true perspectives can be made by choosing different scales for the length, breadth, and hight of the object with corresponding angles. If a different scale is used for each of the three dimensions the projection is called a trimetric one, and evidently there are any number of such possible. When two of the three dimensions are measured by the same scale and the third by a different one the projection becomes dimetric; of such there are of course also any number possible, but there is one that is very easily handled and that yields very satisfactory pictures. In this particular dimetric projection the ratios of the scales are: 1 : ½ : 1, and the angles that the projections of the lengths and breadths of the object form with the vertical are such that their cotangents are ⅛ and ⅞ respectively, so that they may very easily be constructed. I had an instrument made some time ago consisting of a quadrangle embodying the above angles and a right angle. A sketch of the instrument is given herewith together with a little perspective view showing its application.

To make the object appear full size in the perspective view the unit of scale employed for the same should be to the unit of the scale by which the actual object is measured as 1 : 94; in the same manner as the scale employed in an isometric drawing is to the actual scale as is 1 : 82. A pair of proportional dividers are used to advantage. As in isometric drawing circles, of course, appear as ellipses. The centers of the circular arcs approximating these are easily located with the help of the instrument as will appear from the accompanying sketches.



DIMETRIC PROJECTIONS.

The Talking Machine.

Bulletin No. 49 of the American Chamber of Commerce is partly taken up with a paper by Alfred Clark, member of the Chamber, on the subject of the talking machine, and in this paper the author speaks of a use to which the talking machine is being put, which is new to us. We quote as follows:

Some three years ago, Francesco Tamagno, the Italian singer, whom the world's critics have classed as undoubtedly the greatest tenor of this age, approached the Gramophone Company with the hope of obtaining a few records of his voice to leave as a legacy to his children. He wished them to enjoy his voice in the future, when he himself would no longer be able to sing to them. Tamagno himself was skeptical of the result, as well he might have been, for it was the first time a really great singer had sung into a talking machine, but the records were successfully made and have since become universally known and admired. Upon Tamagno's death, which occurred so suddenly toward the end of last year, these records possessed at once an added interest, and the French Government immediately considered the question of founding a museum, wherein the voices of the greatest singers of the present day could be recorded for the edification of future generations.

In taking the initiative in this matter, the French Government has followed the best traditions of its predecessors, who have always guarded so jealously all works of art—a policy which has made the French museums probably the richest in the world. . . .

Tamagno's voice is the first to have been so recorded. The method employed is interesting. The records themselves, which have been made on specially prepared plates, have been inclosed in hermetically sealed metal boxes containing a chemical compound to protect them for future years. These boxes have been engraved with the date upon which they are to be opened—one in 50 years, another in 100 years, and so on, the dates having been chosen to conform with the musical festivities which will undoubtedly take place at that time. This means that future generations will be able to enjoy the voices of artists long since dead, and who, otherwise, would have been to them only a name, and they will be able to compare the singers of their own times with those of bygone generations. We know that Malibran was one of the greatest sopranos

of her time, and yet we are unable to judge whether she is to be compared with the Adelina Patti of our own days. This uncertainty will not exist in the future, for the records will permit of absolute comparison—thanks to the perfection now attained in the recording of the voices which are being placed in the Museum at the Opera.

A Job for the Heavy Swaging Machine.

BY A. SMITH.

The finished forging, Fig. 1, shows what can be done on a heavy swaging machine similar to the Armstrong Whitworth type and a description of how it is done and the swages used may be of interest.

This machine has four rams making about 600 blows of 1-inch stroke per minute. It has also four lower rams which are adjustable to suit the particular job, and they can also be moved when required while operating on the forging. The diameter and length of stock required are determined by trial. It is easier to make two heads than one at the same time, as all the forces are balanced and hence there is no jerking of the forging as would happen when making one; for this reason as well as the manufacturing one the stock is cut off long enough to make two complete forgings. The stock is heated, preferably in a gas or an oil furnace, and rotated along the cutters, dividing it into two equal lengths as seen in Fig. 2, when it is transferred to the heading swages, Fig. 3. The groove formed by the cutters is run on the sharp edge of the lower swage and then is rotated along from right to left until it comes out at the other end, producing two well formed heads as shown in Fig. 4.

The 1½-inch diameter stock gives about the right amount of material which the swages can take in to form the ball. To use a larger diameter of stock is to have a poorly formed head which will be anything but spherical and will take a longer time to swage.

The end of the stock is next drawn out in the reducing swages, Fig. 5, then flattened down to the required breadth and width on the other end of the same swages by alternately passing it through first one way and then the other as can readily be seen. All of these operations are rapidly performed, the forgings being then separated, and this finishes the first heat.

The second heat consists in forming the V-shaped part, Fig. 6, intended to fit over an inch-square bar, and in making the quarter twist, both as seen in the finished forging, Fig. 1. The forming swages, Fig. 7, illustrate how the V is set in, the swages being shown in the open position. The forging is located between the strips and the lower ram is moved up quickly while the blows from the upper ram bend the forging into the shape shown, the strips, which are of the same thickness as the forging, acting as stops.

The quarter twist is made by the fixture shown in Fig. 8, which consists of two main parts, the holder, and the key, the construction of both being clearly

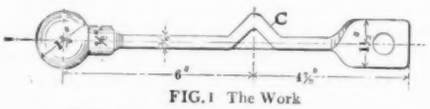


FIG. 1 The Work

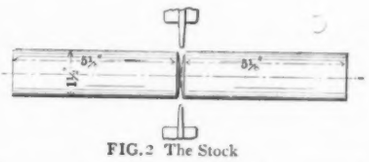


FIG. 2 The Stock

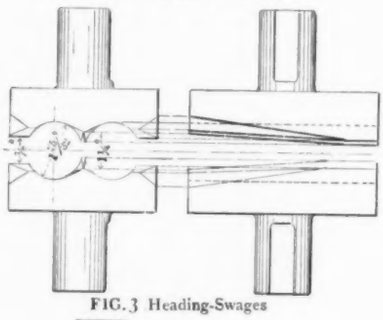


FIG. 3 Heading-Swages

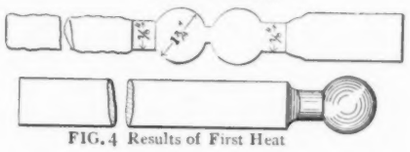


FIG. 4 Results of First Heat

FIG. 6 Results of Second Heat

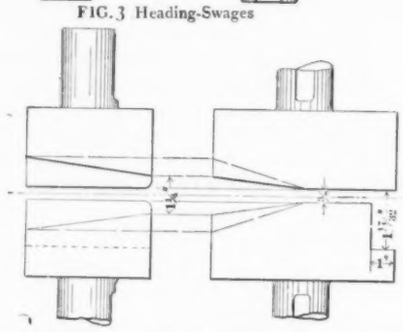


FIG. 5. REDUCING- AND FLATTENING-SWAGES.

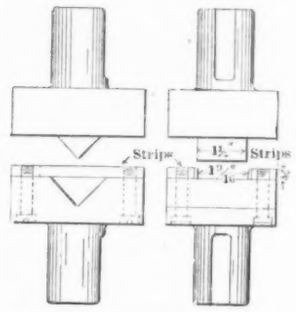


FIG. 7. FORMING-SWAGES.

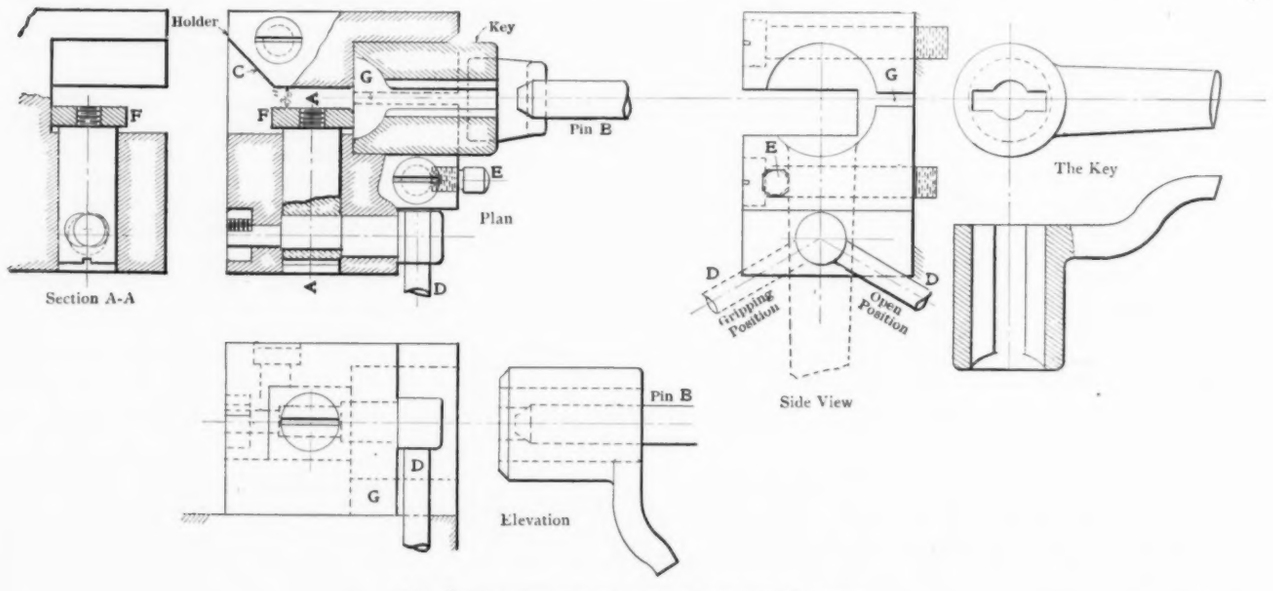


FIG. 8. FIXTURE FOR MAKING THE QUARTER TWIST.

shown. The face *C* on the V of the forging is brought up to the face *C* of the holder; the key is moved along the pin *B* on which it rests as shown in the elevation and which also keeps it central with the socket in the holder. The plan shows it in place ready to make the quarter twist. The lever *D* which operates the gripping plate *F* by means of an eccentric pin is then raised, after which the key is rotated until the handle strikes stop *E*, twisting the forging with it to the required angle. The forging is removed by slipping the key back on to pin *B* and then pushing lever *D* back to the open position.

In a fixture which is likely to become hot by contact with the material operated upon and where scale gathers, gripping screws are objectionable owing to the difficulty of retaining the gripping plate such as *F* in place and also on account of lubrication. The reason for using the eccentric pin which is quick in its action and self locking is mainly to overcome this trouble, and it is a good construction. In order to get rid of the scale which will naturally gather in the holder socket, a slot is cut at *G* into which all the scale will drop, keeping the socket clean for the key to operate in.

These tools are forged from steel, except the quarter-twist fixture, the holder being a gray-iron casting. All are carefully made, the swages requiring special care in machining, as will be apparent. The swages are arranged in the rams so that the operator passes from one to the other consecutively: first, to the cutters, second, the heading swages, third, the reducing and flattening swages and fourth, the V-forming swages, the quarter-twist fixture being conveniently located at the end of the machine. Adjustable gages are also fixed to the machine and locate all the positions while forging that are necessary.

This forging furnished a good example of some of the many operations which can be performed on a heavy swaging machine. The operator of such a machine need not be a smith, in fact my practice is not to have a smith, but a good smith's helper, as he can be more readily taught and such work is also a step in the right direction for him. This machine takes care of a class of work which is often done on the drop stamp and produces a forging which is accurate, neat and has no fin, and hence leads to little loss in scrap at a price ranging from ½ to 1 cent per pound.

In Europe lead wool is much used for making the joints of gas and water mains. It is in the form of fine threads cut from virgin lead, a strand being three feet long and weighing about one pound. First they put a good deal of yarn in the joint and then a turn of lead wool, which is well calked (without heat) and then followed by another turn and so on.

Automatic Press.

The illustrations show a power press equipped with an interesting combination of single roll feed, dial feed and safety stop attachment. The stock is fed from the reel through the medium of the roll feed, which carries it under the cutting

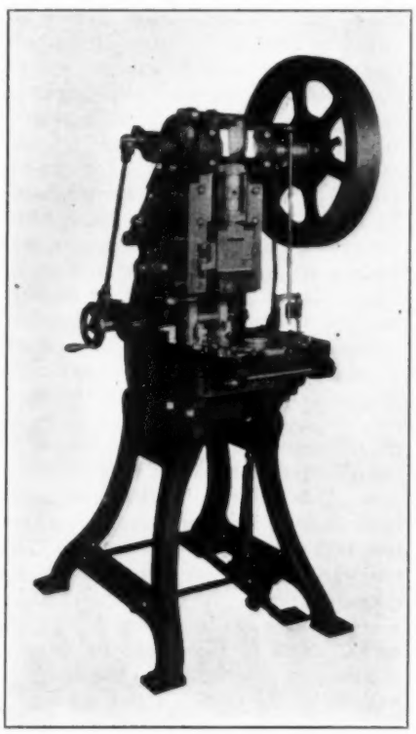


FIG. 1. GENERAL VIEW OF AUTOMATIC PRESS.

punch. Besides cutting the blanks this punch forces them into the dial, by means of which they are passed under the second and third punches where they are operated upon. The two feeds obtain their motion in the usual manner. An important part of the press mechanism is the posi-

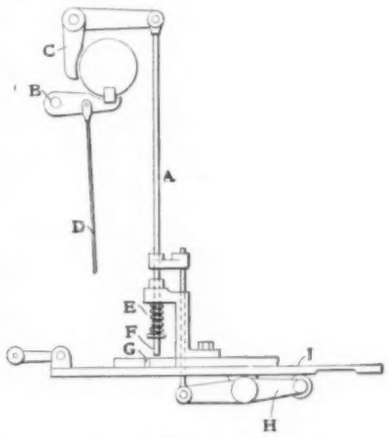


FIG. 2. THE SAFETY STOP.

tive stop which is represented at *A*, Fig. 1, and whose operation will be understood from the sketch Fig. 2. The press is provided with two latches *B* and *C*, as shown. *D* is the treadle rod. Pressure on the treadle releases the first latch. The second latch is connected with rod *A*, fitted with the compression spring *E*, which has a tendency to pull the latch away from the shaft, allowing the clutch to engage. Before this can be accomplished, however, it is necessary that the end of the rod *F* enter the small holes *G*, formed near the periphery of the dial, and if this does not take place the slide will not descend, as the second latch will prevent the engagement of the clutch. It will be understood of course, that the spring rod *F* is lifted from the hole *G* by the rocker arm *H* and reciprocating slide *I* which carries the pawl for feeding the dial.

No dies are shown in the machine, but it is adapted for the manufacture of a large variety of work requiring two or three operations, and the combination of the feeds makes it a convenient press. The total weight of the machine as shown is 800 pounds approximately. It is built by the E. W. Bliss Company, Brooklyn, N.Y.

Milan International Exhibition—I.

BY I. WILLIAM CHUBB.

The Milan International Exhibition (from April to November) is being held, as everyone knows, to celebrate the opening of the Simplon tunnel. Northern Italy now has an additional railway communication with Switzerland and the rest of Europe, the new tunnel supplementing the Mont Cenis, Gothard and Brenner routes. The Simplon tunnel, about 12¼ miles long, or, say, three miles longer than the Gothard, is of course the longest tunnel yet cut. As originally intended, the exhibition was not to be international and was to be devoted to land and sea transportation, the connection between these and the tunnel being quite obvious. It will therefore be found that the most interesting section to engineers is concerned with locomotives and railways generally, while after that the maritime section makes a good second. But the scope of the exhibition has been enlarged, and the industries of northern Italy are fairly well represented, while the fine arts have their own section.

Milan is, of course, the commercial capital of Italy. It is a cosmopolitan rather than a typical Italian city, and is famous to the outsider for its beautiful Gothic cathedral—with its population of about 6000 statues—and for La Scala, where the dancers come from. Its exhibition is, so they say, the first of the kind that has been held in the country. It has been supported financially both by the Government and by the Municipality, and besides this, the sum of 3,000,000 lire is being raised by a State lottery. How far the enervating effects of lotteries are compatible with true economic and industrial advance may perhaps be questioned. For some idea of their result on the Italian temperament read Mathilde Serao. Still the English-

speaking countries have their betting, and cannot throw stones. Anyway, the northern part of Italy during the past 20 or 30 years has rapidly been becoming an industrial country. Here the greatest enterprise has been manifest. The development of southern Italy is perhaps only beginning. The industrial awakening may almost be said to date from the political unification of the country. Some of the engineering firms are avowedly attempting to render Italy self-contained. Many of the businesses have been carried on by foreign, and especially by British capital. With the awakening of the spirit of nationality, Italy is now in many instances ambitious of achieving her own economic salvation, of setting herself free by the expansion of her industry, and of opening up both a home and an export trade. English public opinion was quite ready politically to help the Garibaldi movement. The newer attempt will perhaps not be supported quite so heartily. The rapidity of recent developments is shown in certain instances by want of Italian technical terms. Of engineering industries none has been taken up with more eagerness than the manufacture of motor cars. In Milan alone there are perhaps a dozen firms, small and fairly large; but in Turin there are, say, three dozen firms, all of some size, headed by the Fiat Company, of whose works an account will shortly appear. Indeed, as to Turin, the current native joke has it that a stranger, knocking at any door and inquiring for the new motor works, will nine times out of ten be invited to walk in.

MACHINE TOOLS.

Regarding machine-tool building, however, little has been done or is being done. Twenty to twenty-five years ago English tools were imported. Then came the turn of the American tool, and later still the German machines prevailed. There was good reason for this, for the Germans came into the district, studied the needs and did their best to supply them. In many cases, English firms in particular, did not take a great deal of trouble. After quoting occasionally in a desultory way, they omitted even to go through that formality, thinking after one or two failures that the inquiries were not firm. The activity of the Germans in many cases took the form of copying and cheapening American designs. They still, in some instances, retain the high opinion thus shown of American tools, for one attendant in the exhibition expressed himself by stating that "the German machines were good, but the American machines were very good." It is but natural that the machine-tool industry of the district should not flourish to a large extent. The fickle side of the Italian character has shown itself in the readiness to throw over other branches of engineering for the motor-car trade, and the tool industry has suffered. The firms that really matter can be counted on the fingers of one hand; but there are a number of small concerns making lathes, and so on, at odd times, and in no organized or extensive fashion. Of the machine shops now in existence, the firm of Du Bosc, of Turin, is one of the most important. They are, in fact, re-establishing themselves, and building new shops, their specialty being lathes and bevel-gear generating machines. The Michele Ansaldi firm, of Turin, makers of cheap machines, were after a time absorbed by the Fiat Company. It is, however, being established again on a separate basis, and new works are being set up in Turin, so that produce in the way of machine tools may be looked for very shortly. Another going concern in Turin is that of Antonia Masera, while the firm of Roberto Züst, of Intra, which was founded nearly 60 years ago, and who made some really good machinery in the way of planers, punches, drills and American-type lathes, has followed in its development fairly along the lines of the Ansaldi Company. In Milan they make automobiles, but at Intra, where the works etc., are said to cover some 50,000 square meters, and where 700 or more men are engaged, the manufacture of tools is the principal business. In Milan itself, perhaps the most important firm of machine-tool makers is Macchi & Passoni. This business is carried on now almost on co-operative lines. It was established 25 years or more ago by Macchi & Izar, and on the death of the latter, the foreman became part proprietor, and the men took a share of the profits, a step which has been followed in several other instances.

OTHER MACHINE INDUSTRIES.

Other branches of engineering carried on in the Milan district are the hydraulic, represented by such a firm as Riva, Monneret & Co.; electrical traction concerns, as Officine Meccaniche; and some half-dozen electrical engineers, as the Gada, Brioschi, Finzi Company. There are no textile engineers. Agencies of all kinds abound. In fact, the best machines are being readily bought. But they are not used to their fullest advantage. The AMERICAN MACHINIST readily makes its way. English engines for producer gas have recently sold well, dearness of the necessarily imported coal telling in their favor.

WAGES AND INDUSTRIAL CONDITIONS.

The wages of Italian engineering work people are low all round. Even a skilled man gets as little as 2 or 3 lire (say 1s. 6d. to 2s. 2d., 36 to 54 cents) a day, while a very good turner in Turin may receive from 45 to 50 centesimi, or less than 5d. or 10 cents an hour. A good fitter can be had at the rate of about £1 per week. Regular apprenticeship is not practised. The young worker may give two or three years, and then receives a small wage. A laborer in the country may get 3d. a day, while girls similarly employed may be paid even as low as 1d. (2 cents), a day, in the South. Socialism grows.

As to trade organization, this is extending, a great weakness being lack of funds. Mutual support societies followed the unification of the country, principally first as local societies, then as federations. Local chambers of labor were inaugurated in 1891 in Milan but according to Angiolo Cabrini, differences in the democratic forces have weakened the organization of the workers. An endeavor is being made to unite in one central body or central secretariate of resistance. The latest available figures showed at the beginning of 1905 about 175,000 members of trade federations while the 33 chambers of labor had about 188,500 members. In the federations, 13,313 members belonged to the metal-working classes. According to the authority quoted above, the labor press consists of 27 papers. Again the only compulsory insurance is against accidents. Employers pay the premiums, and must not deduct them from the wages. To insure this, one inspector covers the whole of Italy, aided by the police. Workers in small industries, home workers and clerks are excluded. Children under 12 may not work in factories. Arbitration courts are provided, composed half of workers and half of employers, but it is complained that employers will not always take part in them. The courts do not apply to State workers of any kind, nor to agricultural workers.

The working day usually consists of 10 hours from Monday to Saturday. Many offices are open for a time on Sunday also, at least for the morning, except, perhaps, during the hot weather. In some cases, where Sunday work is paid for at a rate of time-and-a-half, the workmen have insisted on being in attendance for the morning. The newer social ideas are rapidly being disseminated among the workmen. They are glad to gather anything fresh, and, being capable, work well, although not always systematically. All things considered, the workmanship is good, and it is obviously cheap. The rapidity with which the automobile industry has extended is proof of the national readiness to take an opportunity. Indeed, in Turin, good engineering workers are not to be had, and men are being taken from anywhere to work the machines. The workmen go abroad, even to France, where they get more money, and do not always return. Often, however, the Italian emigrant does return; moreover he remits money regularly to the mother country. In his new country he works at a lower rate than the native, and, having a lower standard of living, he is able to save, however small his wages. Often, in fact, he puts by enough to acquire a small plot of ground, to which he returns, and on which he lives the remainder of his life. The work people are naturally in these circumstances at first rather rough, being ill-trained and uneducated; but they are intelligent. Technical evening classes are increasing in numbers, and advantage is be-

ing taken of them. Still, with the climate, and the long hours of work, the would-be students are heavily handicapped. The introduction of the mechanical industries is raising the standard of living among the poorer people, and with this rise come fresh demands for increased wages. Strikes are therefore not infrequent, and these troubles have been held responsible, to a certain extent, for the backwardness of the Milan exhibition at the time of its opening. The system of education is carried on practically for seven months of the year, the three months from July to October being the hot period, when the schools close, while about two months are taken up by smaller holidays, as at Christmas time, and so on. The period of education is extended as compared with some other countries; but the native students are naturally quick, and are helped by their teachers to a larger extent than is common in Great Britain. Instead of being left to investigate a subject for themselves, the skeleton outline, and rather more than that, will be presented to them by the lecturer.

In the towns there is very little home life, the people living on the flat system. Consequently the buildings are of a more imposing character than will be found in industrial centers in Great Britain. Another feature that may be noted is the use of the 24-hour system of time. This has been official for some half-dozen years. Still the ordinary a.m. and p.m. system is regularly followed in ordinary business and conversation, and as a matter of fact, the casual observer in Milan will have difficulty in finding a public clock divided for more than 12 hours. Official announcements are made on the newer fashion, the exhibition, for instance, closing at 24. In other semi-public occasions the two systems are sometimes employed. Thus in announcing a pelota match, the time will be given as 21.15—9¼.

MINERAL WEALTH AND POWER DEVELOPMENT.

Although the mineral wealth of Italy is considerable, it is undeveloped because of the difficulty of reaching it. The biggest industrial asset of Northern Italy lies in its waterfalls, from which electric energy is obtained. The chief impulse in this direction dates perhaps from the 3-phase, 15,000-volt, Poderna transmission of 1896. In the Milan district, for instance, about 60,000 k.w. of hydraulic-electric energy is already available, while besides this a reserve steam plant of about the same capacity is kept. Indeed in some individual cases the steam reserve is greater than the hydraulic plant, and it has thus been found that the water system has actually produced a demand for steam plant. In factories, etc., the latter is being supplanted by the electric drive. For power purposes flat rates are charged; but for lighting the maximum-demand system is in use.

The municipal authorities of Milan are doing their best to popularize electric power, and have installed a plant which supplies the smaller factories, and also helps to keep down the price of the supply company. This cheap electric energy combined with cheaper labor, and the keen mental qualities are held to suggest the probability of a great industrial future for northern Italy. The control of the street railways in Milan may be mentioned as being somewhat peculiar. The municipality supplies the rails, and decides on the number of cars to be run, and also their destination. In short, it is said no car can move except with the permission of the municipality. On the other hand, the company supplies the power, the cars and the men, and is paid according to the distance the cars are run. When the company's concession runs out, the municipality will, it is confidently anticipated, work the roads entirely itself. Local control, in other respects, is fairly complete.

London.

Experimental Technology of Deformation of Materials, and Its Application to Metal-Working Processes—II.

BY H. I. HANNOVER.

SECTION I—EXPERIMENTS ON DEFORMATION BY COMPRESSION AND THEIR PRACTICAL APPLICATION (CONTINUED).

C. FURTHER EXPERIMENTS, THEORY AND APPLICATION TO THE PROCESSES OF EXTRUSION AND PRESSING.

Some of the most known compression experiments with plastic bodies will be those, which Tresca some time made in Paris by pressing such materials out of an orifice in the bottom of a cylinder by means of a ram. He showed that the deformations in solids are quite similar to the movements of the molecules in a fluid which flows out of an orifice. For this reason Tresca brought into use the French name *écoulement*, that is, "entering in the liquid state," or, as is generally said in English, "yielding," * for the deformation of plastic bodies.† It was thus shown by Tresca what form a number of circular lead disks take when they are pressed out of such an orifice (Fig. 18), and he set up a calculation of the form of the meridional section of the extruded jet. It was further experimentally shown by Tresca, how the material always escapes at the point where it meets with the least resistance. Plenty of similar experiments are made by A. v. Obermayer.‡

*We should say "flow" is the better corresponding English word.—Ed.

†Tresca's treatise: "Mémoire sur l'écoulement des corps solides" in "Annales du Conservatoire des arts et métiers" 1865-66, p. 9 (see also an extract in "Comptes rendus" 1864, Vol. LIX, p. 754).

‡A. v. Obermayer: "Versuche über den Ausfluss fester Koerper insbesondere des Eisens, unter hohem Druck, Sitzungsberichte der kgl. Akad. der Wissensch. in Wien, 1904.

KICK'S LAW OF PROPORTIONAL RESISTANCES.

Next to Tresca's experiment those of Kick may chiefly be noted, some of which have already been mentioned. Of this author's other experiments may further be named those made for demonstrating his "law of the proportional resistances."* The first part of this law indicates, that to impart to geometrically similar bodies of the same material proportional deformations—using equal velocity—it is necessary to apply work which is proportional to the weights of the bodies, while the second part indicates that the pressures which are required for the deformations referred to are proportional to the sections or the surfaces of the bodies.

FIG. 18
Lead Disks pressed through an Orifice.

FIG. 19.
Clay pressed through an Orifice.

A third part of the law is to some extent only a transcription of the first part.

Kick has thus by carrying out the experiment shown in Fig. 18 on geometrically similar cylinders shown that in accordance with the second part of the law the pressure on the rams, when these were in corresponding positions, was proportional to the sections of the rams, and that in accordance with the first part of the law the work required for the extrusion was proportional to the volumes of the cylinders.

If, for instance, the linear dimensions of the small cylinder are half the dimensions of the large, and accordingly the orifice in the small cylinder has a diameter which is half the diameter of the orifice in the large cylinder, then there will be extruded $2^3=8$ times as much material from the large cylinder as from the small, but there will also be required 8 times more work. The

*Kick: "Das Gesetz der proportionalen Widerstaende." Leipzig, 1885.

law is, of course, not exactly true when some of the material is squeezed in between the ram and the cylinder; in that case the friction will be proportionally larger in the small cylinder.

Not regarding such secondary effects, whereof there of course practically must be taken necessary notice, the law is on the whole exact and may be used to find out by experiments on a small scale what pressure is necessary on a larger scale. Kick has by experiments on clay shown that the necessary pressure—acting on the ram—keeps nearly constant until the ram reaches the sliding-cone *a b c d*, Fig. 19, which is formed under an angle of about 45 degrees on the bottom of the cylinder and along which the material slides down toward the orifice; but hereafter the necessary pressure increases quickly.

In the technics the mentioned method of pressing, extrusion, is very often made use of, for instance in the metal technics for pressing of lead wire and lead tubes, of bars of delta metal, etc.

Kick's law may further be used for finding out—after experiments with pressing of small, red-hot iron cylinders—what forces must be put in motion by large, hydraulic forging-presses to obtain a proportional deformation.

Besides, Kick's law is also true with regard to action by shock. Its application to forging with hammers, striking with the same velocity, is for instance already shown by Tresca in 1865, and it may therefore also be used to find out by experiments on a small scale, what sizes of hammers are required on a large scale.

In the treatise referred to in the footnote Kick renders on page 81 an account of his experiments in order to prove that solids, like fluids, cannot be compressed perceptibly, but are almost quite constant of volume. A metal, as for instance steel, can only be compressed so far that the blow-holes it contains are flattened and the grains it consists of are squeezed more tightly together; and even india-rubber, which is likely to be compressed to a smaller volume, will in fact by compression in one direction expand so far in other directions that the volume keeps constant. On this fact the German civil engineer, Mr. Huber, has based his wonderfully beautiful method of pressing, mentioned in the AMERICAN MACHINIST in Vol. 25 (1902), p. 765; by means of an enormous hydraulic pressure he makes an india-rubber bag, which he places inside a pressed metal vessel, force this vessel into all the details of an external matrix, whose single parts are joined in such a way that every one can be removed from the article when the pressing of the latter is completed.

Fine measurements of the variation in specific gravity of metals, when they are exposed in ricinus oil (castor oil) to enormous pressures, are made by Kahlbaum and others.*

D. FURTHER EXPERIMENTS AND APPLICATION TO THE PROCESS OF ROLLING.

Before going on to describe more fully, in what way experiments on compression and the theories derived are of consequence for understanding the squeezing effect that rollers have on a material, which is going to be rolled down to a smaller thickness, we will for the sake of completeness mention how the rollers are able to drag the material in between themselves.

DRAWING-IN BETWEEN ROLLS.

We will suppose that a flat material, whose foremost face is presumed to be vertical, is brought forward in the direction of rolling, until, as shown in Fig. 20, it touches each of the two revolving rollers along a single generatrix, and that then the upper roller is lowered a little. The rollers will then possibly carry the material along or, as it is called, draw it in, because there will in that case arise a certain pressure in the points of contact between the material and the rollers and on that account a certain friction between

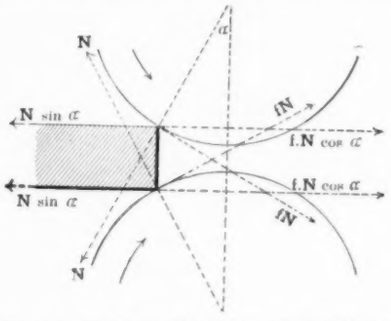


FIG. 20. PIECE OF MATERIAL ENTERING BETWEEN ROLLS.

them. This pressure must act in the direction of the concerned radius of the roller, and we will suppose that the radius forms an angle α with the vertical plane through the axes of the rollers. If the pressure on behalf of one of the rollers be called N, then its horizontal component $N \sin. \alpha$ will be the resistance, which, if there is to be any drawing in, must be overcome by the friction's horizontal component $f N \cos. \alpha$, f being the coefficient of friction. With respect to the other roller we get the same expression, if we for the sake of simplicity suppose that the diameters of the rollers are equal.

The condition upon which the material is drawn in by the rollers, is thus seen to be $f N \cos. \alpha > N \sin. \alpha$ or $f > \tan. \alpha$, *i.e*, *the coefficient of friction must be larger than the tangent of the center-angle* α.

Further it will be seen, that the condition is independent of the size of N; this is, however, only true when the pressure is entirely produced by the rollers, but not otherwise; for instance not when the material is pushed forward. If the condition named, $f > \tan \alpha$ is satisfied, then it will be sufficient for obtaining the drawing-in of the material to lower the upper roller so far that there arises a small pressure N.

The condition found is, however, only applicable at the beginning of the rolling, because gradually, as the material is sucked in between the rollers, the circumstances which favor its passage change—a fact that can easily be proved. If for instance the foremost end of the material has passed the mentioned vertical plane through the axes of the rollers, that is to say the spot where the rollers are nearest to each other, then there will in reality be an infinite number of different pressures in all the points of contact between the material and the rollers. Now suppose that we would in a similar way as above find out the condition for drawing-in required in this case, by summing up the two quantities $N \sin. \alpha$ and $f N \cos. \alpha$ for every single point of contact in a vertical section-plane through the direction of rolling, the angle α varying from the value α to O, or more exactly to a small negative value, because the material squeezed between the rollers—owing to its elasticity—expands a little when it has passed the spot where the rollers are nearest to each other. Such a calculation could not, however, be carried out, for the fact is that the law, according to which the pressure N varies, is not known, but with reasonable presumptions for this law* it is found that the resultant N_1 of these pressures with respect to any of the rollers passes through its center and forms an angle α_1, nearly equal to $\frac{2}{3}\alpha$, with the vertical plane through the axes of the rollers.

The condition for the continued drawing-in of the material is therefore in this case $f > \tan. \alpha_1$, but this condition will always be satisfied, when $f > \tan. \alpha$; consequently there will at the beginning be most difficulty in making the rollers draw in the material, but when they have commenced, they will easily continue to do so.

If on the contrary the coefficient of friction f originally is not greater than $\tan \alpha$ the rollers will, of course, not of their own accord be able to draw in the material, when as mentioned above the upper roller is lowered a little.

In that case various remedies may be used.

First, *the coefficient of friction* f *may be increased*, for instance by roughening the surfaces of the rollers or by sprinkling the surface of the material with sand, means which, however, only may be used at the preliminary rollings; thus, for instance, the last means if used at the finishing rolling of steel plates would make them scarred.†

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*"Zeitschrift für anorg. Chemie," 1902, p. 254 and "Dinglers polyt. Journal" 1905, Vol. 320, p. 169.

*See Codron: "Procédés de forgeage," Paris, 1896, Vol. 1, p. 314.

†Or turpentine may be used as mentioned at p. 733, Vol. XXIX, Part I.—Ed.

Second, *The center-angle* α *may be diminished* either by increasing the distance between the rollers, so that the material from the beginning can be brought farther in between them, or by using rollers of a larger diameter. If α is reduced in one of these ways the thickness of the material will, however, by passing once between the rollers not be decreased so much, or, as it is termed, the rolling-down is diminished.

Practically the initial pressure N is usually not produced by lowering the upper roller as mentioned, but by pushing the material with a pressure P from behind forward against the rollers; in this case there arises a pressure N_2 and drawing in will be carried into effect when $\frac{1}{2} P + f N_1 \cos \alpha > N_2 \sin \alpha$. This condition is, however, more easily satisfied than the above mentioned $f > \tan. \alpha$; it may be written $\frac{\frac{1}{2} P}{N_1} + f > \tan. \alpha$, so that the remedies mentioned in the first paragraph above may then usually be dispensed with, and perhaps the rolling-down may be made larger than otherwise and hereby the work is accelerated, because a proportionally greater deformation is obtained by each passage of the material between the rollers.

Moreover, we are at times, because of quite another reason, limited in increasing the rolling-down; for, the larger the reduction of the thickness is, the larger will be the pressure, to which the material is subjected, and if this pressure is too great, the material will break. As red-short iron or hard steel—carbon steel—is more brittle than for instance wrought iron, containing little carbon and sulphur, we are more limited with regard to the rolling-down of the first named materials.

SQUEEZING BY ACTION OF THE ROLLS.

This last fact concerns already the squeezing effect of the rollers, which we now are going to examine, after having described their drawing-in effect.

Professor Codron in Lille has by compressing lead disks which were 5 mm. thick, 0.5 mm., that is 10 per cent., found that the force per sq.mm. of area required herefor was about 6 or 7 times smaller when the diameter of the disk was 10 mm. than when it was 10 times larger, that is 100 mm. The reason for this fact is of course, that in a disk with a large diameter the middle portion of the surface is not so easily pressed down, because the part beneath it can only with difficulty escape sideways; see also the experiment on the copper cylinder between the lead disks, Fig. 10. A vertical prism, whose cross-section has a certain area, will consequently more easily be compressed when the form of section is very elongated than when it is quadratic. The above mentioned rollers are in fact only squeezing a horizontal, long and narrow strip of the whole metal plate and can, therefore, comparatively easily compress this strip, because the material only has a very short way to go in order to escape sideways, that is in this case in the direction of rolling; and for this reason the material is chiefly stretched out in the direction perpendicular to the rollers and on the contrary only slightly in the direction parallel to the rollers.

Of Codron's experiments it follows further, that rollers of a small diameter stretch the material more lengthways than larger rollers; but as follows from what is previously explained the rollers must have a certain thickness to be able to draw in the material, and, besides, too slender rollers would bend owing to the pressure N_1, if there are not taken special precautions.

From what here is set forth it will be seen that rollers are excellently adapted to squeezing, especially as they moreover, owing to the drawing-in, supply themselves automatically and continually with fresh material for the squeezing. Herein may be sought the chief reason for the large employment which rolling has found.

Iron and steel are chiefly rolled cherry red-hot, because they in this condition are more easily squeezed. At times, however, cold-rolling is used.

Finally we will only mention that when we press a body which consists of soft and hard parts, it is of course especially the soft parts that spread out; but as the hard ones do not keep pace with them, there will arise a stratification, and the cohesion to the harder parts will become small. For instance, in the rolling out of iron bars, as also further in forging of iron blooms (which, however, relates to deformations owing to action by shock), this condition is found, which effects the fibrous structure, as the iron particles during the drawing-out have slid on the slag, which was fluid and was stretched much more quickly.

As a matter of course it is similar circumstances that have produced the schistosity* in the rocks.

On the effect of pressure is thus founded a large part of the most important technical methods for producing deformations, such as it appears from the particulars here given about extrusion, pressing and rolling.

(To be continued.)

In an alleged new German process of hardening, the iron is heated in a powder of bone dust to which are added 300 gr. of yellow prussiate, 250 gr. of cyanide of potassium and 400 gr. of phosphorus, in a closed and clay-luted box, being raised to a clear red or white heat. A warm bath is used for dipping the heated work. It is stated that a 400-lb. piece of iron can be hardened 0.04-in. deep and so hard that no steel will cut it, though it may be welded.

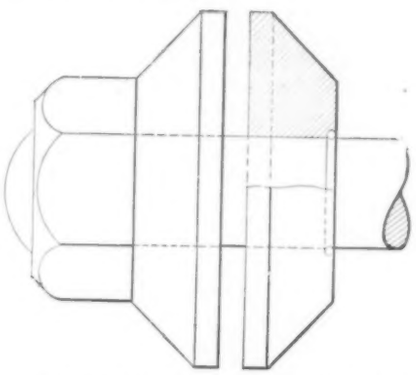
*Lamination.—Ed.

Letters to the Editor.

A Cheap Saw Arbor—A Substitute for a Shoulder on Shafts and Arbors.

Mr. S. A. W. Mill came in one day about ten minutes before noon, and wanted a saw arbor 5 feet long, 1¼ inches diameter at the journals, to fit saws with 1¼-inch holes. He had a pair of boxes and a pulley, but we were to make the shaft, collars and nuts. As usual, he was in a hurry—had to take it back with him. We were busy, and having only one lathe available at the time, saw that it was improbable that one man could get the job out before night, if he had to turn up a shaft from rough stock. How else were we to get a shoulder for the tight collar to back up against?

While eating dinner we worked the upper as well as the lower part of our heads, with the result that Mr. Mill went home with his arbor at 5:30.



SHOWING RING FOR TAKING THRUST ON COLLAR.

We first started the man threading a 1¼-inch nut in the lathe—it had to be left hand, and we had no left-hand tap—while a piece of 1¼-inch cold-rolled steel was being cut off in the hack saw. The total work on the shaft consisted of centering, facing, threading and cutting the small groove shown in the accompanying sketch. Into this groove we snapped a 12-gage wire ring, which one of the vise hands made ready. The collars were bored and faced, care being taken to bore the recess a snug fit for the ring. We drove the tight collar on, and after truing the face, slipped the loose one in place, pinching it tight with the nut, and finished them both on the shaft.

Twice since we have made use of the same device on much heavier work, and as yet have no fault to find with it. In one case we were putting up a 22-foot length of 3-inch shaft in a vertical position; it was impossible to put in a step, and any slippage of the set collars would result in a serious disaster.

In the other case we had a line shaft 5½ inches diameter transmitting over 300 horse-power. It was driven by a water-wheel, and had a large bevel pinion on

one end. The thrust from this pinion had caused trouble periodically for years, and a heavy, split set collar had been added; still occasionally the shaft went back. It stays put now. One Saturday we rigged a suitable rest close to one of the boxes. Sunday we ran the shaft slowly and with a hand tool turned the groove. We took the split set collar into the shop and bored the recess, after getting the size by holding the wire ring in position with a pair of pliers. Notches were filed near the ends of the wire for this purpose. This was necessary, as we formed the wire ring round the shaft, and consequently it sprung away from instead of toward it. In this case we used 8-gage wire. In many cases this device may be used as a very effective shoulder, usually effecting a saving in lathe work.

CHARLES A. TRASK.
VERNE A. TRASK.

How to Check Nuts; Old and New Ways.

Numerous are the devices for checking nuts and almost as numerous are the conditions under which this has to be done.

One of the most used is shown in Fig. 1. As it is generally used, we find that we do not obtain the result sought.

We want to prevent the nut from loosening and falling off; the last we obtain, but the nut has a chance to loosen till it touches the split pin, the distance *a* varying greatly in different bolts. The split pin is also often the cause of accident, if used on moving parts. The cleaning of engine parts, on which the split pin is used, is no easy job. A very disagreeable job too is the replacing of split pins, as they lose their shape so easily and are not easily brought to shape again. This explains why we sometimes find a nail or wire used where a split pin should be, the machinist having failed to get the split pin in shape again and having no other on hand helped himself thus. If a split pin be used it should always be placed as shown in Fig. 1 *A*. Should the hole not be drilled in the proper place, a tight fit between nut and pin is easily secured by putting a washer under the nut, or by filing off the pin or nut.

By using a taper pin as shown in Fig. 2, the nut is well secured. Some are inclined to think that this device weakens both bolt and nut, but this is not the case as the construction will be perfectly safe, if we put the taper pin in the upper half of the nut.

According to Prof. Reuleaux the hight of a nut does not need to be more than $0.45d \div 0.4d$ when d = diameter of bolt, as this length of thread will equal the strength of the bolt.

Another position in which the taper pin might be placed is shown in Fig. 2 *A*. This, however, is more expensive as the slot in the nut has to be milled or filed.

Comparing the cost of using split or taper pins, I would judge that by using standard tools the cost of taper pins would hardly exceed that of split pins.

Another device for using split pins is shown in Fig. 3. This one has the advantage that the nut can be secured after 1-12 of a turn, by having four slots in the washer and 6 in the nut; this is used on German locomotives.

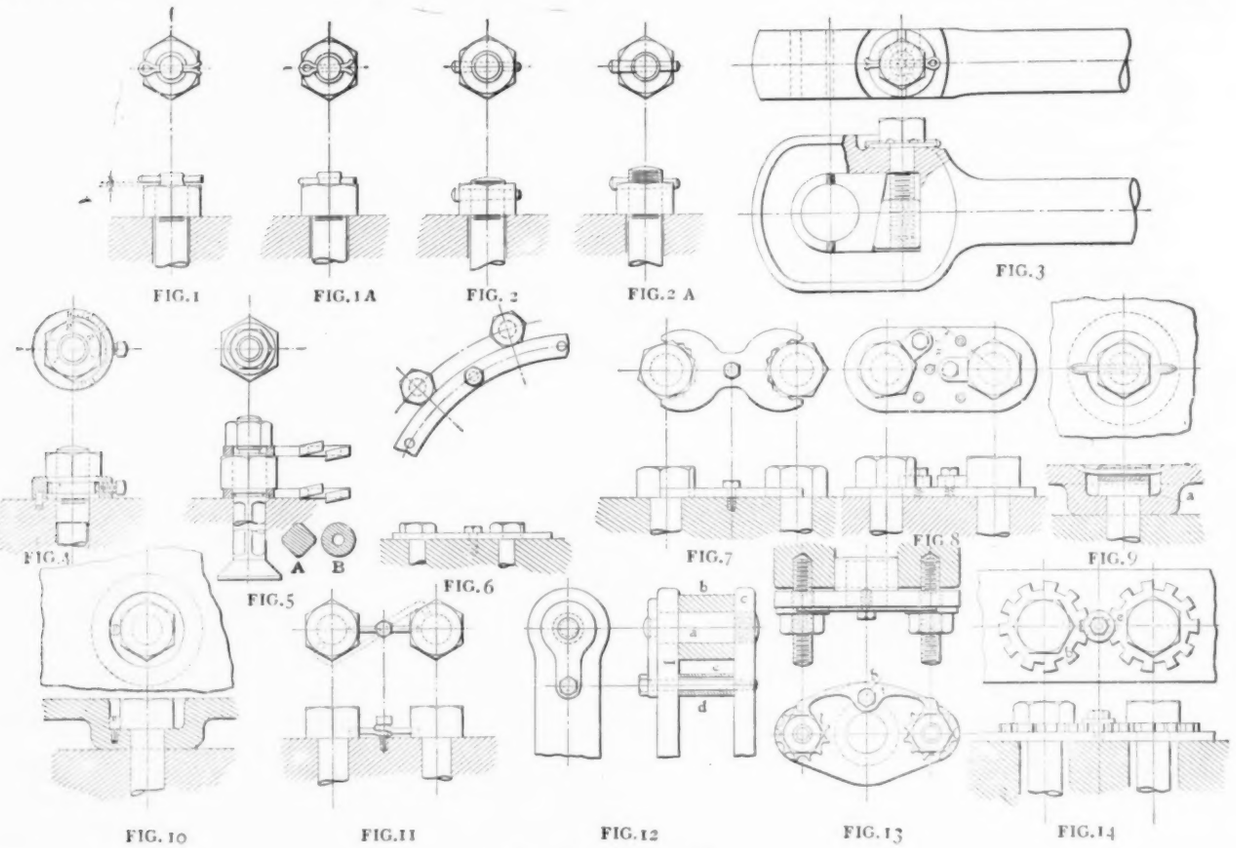
The device shown in Fig. 4 is well known. In case it is used on large bearings it will be found very handy to add a scale and to number the corners of the nut as shown. With this we are sure to replace the nut exactly and thus to get the same strain on the bolt, other conditions being equal.

Fig. 5 shows the Parsons bolt used as a fastening for rails with the sleeper and beam on bridges. In this case the section at *A-B* might have the form of either one of the two shown. This is done with the intention to reduce the cross-section without disturbing the fit of the bolt.

The area to which the bolt body is reduced should, of course, equal the area of the bolt at the bottom of the thread.

Another place where the checking of nuts or bolts is of great importance, is between the follower and the body of a piston; this is especially true with large pistons where a loosening might easily occur through vibration. In men-of war the shock caused by the recoil of the guns has to be taken in consideration as well as the vibration caused by the motion of the ship.

As in such cases the bolts or nuts to be



NUT CHECKING DEVICES.

secured are usually placed in a circle and it is desirable to secure all with one device, this result is easily obtained by following the arrangement shown in Fig. 6.

In Figs. 7 and 8 the device given by Maudslay is shown. Two nuts at a time are secured by using a check plate allowing 1/18 of a turn of either of two nuts and fastening it by means of a cap screw.

Fig. 8 shows another device by which the same result is obtained. Here two neighboring screws have one combined washer. Each nut is checked by a check piece fastened to the washer with a cap screw. There are three tapped holes spaced 40 degrees apart provided for each cap screw, thus allowing the securing of the nut every 1/18 of a turn. By using the devices given in Figs. 6, 7 and 8 it is understood that the nuts or heads of the bolts project. Often it is desirable to have the tops of the heads of the bolts or nuts flush with the top of the follower. In order to obtain this result, we might counterbore and use the arrangements shown in Figs. 6, 7 and 8. In Fig. 9 a very simple and cheap device for checking the heads of bolts is shown. A hole has been drilled through the upper half of the head, and after tightening it up as desired, two small grooves are chipped corresponding to the hole. A straight steel wire is then put in position and will by its elasticity prevent the loosening of the bolt. The ends of the wire are finished flush with the follower. In order to secure a steam-tight fit at *a* a thin washer of soft copper might be placed under the head. Fig. 10 shows another device.

A machine screw is placed in the position shown and tightened up, thus preventing the loosening of the bolt. This screw might of course also be used when the nut projects.

Another device for checking bolts or nuts is shown in Fig. 11, where a steel wire is used as a check pin. By drilling one hole only in each bolt, and by fitting the wire according to the location of these holes we might check the bolt in any position. See dotted lines.

Fig. 12 shows a very handy and simple device for checking link pins. The pin *a* is riveted in the flat piece *b*, while the other end is screwed in at *c*. The bolt *d* is put in position as shown, thus preventing the pin *a* from loosening. A piece of wrought-iron pipe *e* of proper length prevents *f* binding. This is used on German locomotives and cars in hanging springs.

A simple device for checking nuts on gland studs is shown in Fig. 13, the nut and the washer being in one piece. The circumference of the washer should be notched as shown or in a similar way. The check piece *a* is made from sheet steel and fastened to the gland with the cap screw *b*, but should be a free fit on the bolt. This construction permits the shortening of the length over all by about 3/8 of the hight of the nut as usually applied.

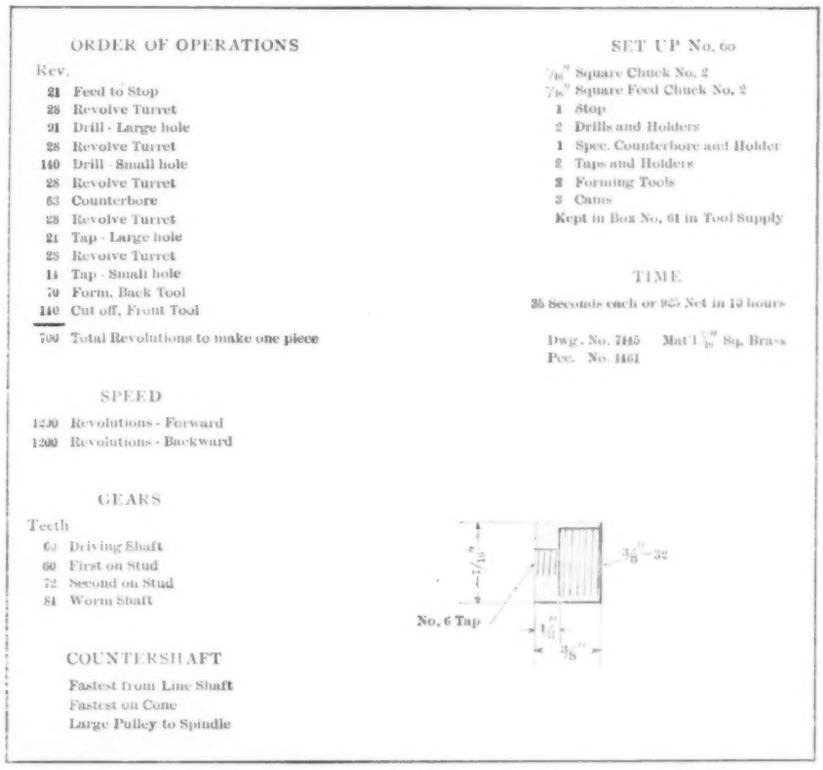
Fig. 14 shows the device given by Penn for checking nuts used to hold propeller blades in place. In this case the nuts require a washer common to two or more studs. A small plate *b* is placed over each nut after tightening it up as hard as possible. These plates require a hexagon cut-out inside and 11 teeth on the outside. The checking piece *e* prevents the nuts from turning and is kept in place by a cap screw. This device allows the securing of any nut after 1/66 of a turn has been made.

WM. BOEHLER.

Setting Automatics.

I have read with interest Mr. Schkommodan's article at page 843, Part 1, on this subject, and give below our practice in connection with Brown & Sharpe automatics. The system we follow has proved very satisfactory. When we get a piece to make and are sure that we will have it again we lay out a set of three cams. When figuring out the cams we write up the order of operations, speed, gears, order of belts on countershaft, and list of tools to use, giving them a "set-up" number and a box number with the time for each piece, number of pieces in 10 hours (less 10 per cent.) material and drawing number. The number 2 after "chuck" on the setting-up print is the size of the machine. The sketch of the piece is also put on this sheet, but tool setters are not allowed to go by it as the drawing may have been changed since last used. We send this to the draftsman and he has a tracing made and furnishes three blueprints. One is pasted on a folder and put with the tools in a box for the tool setter's use; one is put in the foreman's book and kept for reference, so that when a piece has to be made and no set-up sheet is made for it he can look up the sketches on these prints and find one that will do. The third copy is kept in the tool department. Our practice is to give the tool setter a tag that reads, say, "10,000 7/16 square-brass nuts, Drawing No. 7445; Piece No. 1461." He gets the drawing and on it appears "B. & S. Set-up No. 60." He goes to the tool room and calls for the "set-up." The record shows this to be box 61. The box is handed to him with the folder and he sees what tools he has to get and proceeds to put the tools in the machine in order. By following the print he can set up the work on any No. 2 B. & S. screw machine and know that it will be all right. I have never had but one man that had trouble. He could set up the job without the print. One piece he had was to be threaded and nurled. He worked five hours, tried all the dies he could lay hold of, and finally concluded the cams were not figured out right. When asked if he followed the order of operations he admitted he had not, but that he knew the cam lobes for each tool. His trouble was caused by running the die on with the nurl lobe and nurling with the one for the die; they did look very much alike.

In giving the order of operations the



A SETTING-UP PRINT FOR BROWN & SHARPE AUTOMATIC SCREW MACHINE.

revolutions of the spindle are noted for each, and the total for each piece. We generally make the necessary special tools such as forming tools and special cut-offs, and put them in the box with the cams. If the piece to be made has to be turned and has more than two diameters, it pays to keep a turning or box tool set up. If of only two diameters we use the regular turners. Other tools such as drills, reamers, tap and die holders are kept on hand in sufficient numbers to supply the demand. McK.

A Boiler Shell Puzzle.

A boiler shell, Fig. 1, has a single butt longitudinal joint. The strength of joint equals one-half the strength of the sheet. The strap is extended to form an enveloping shell as in Fig. 2. How much is the strength increased?

FIG. 1

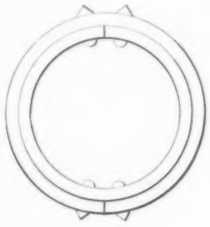


FIG. 2

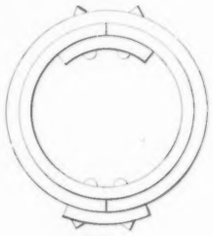


FIG. 3

A BOILER SHELL PUZZLE.

Next these joints are strapped as in Fig. 3. How much is the strength increased?

In a pressure tank not externally heated is the double wall desirable? C. W.

Modern Shop Floors Made Wrong.

An account of a mistake deliberately made by men who certainly know better, and for a concern that delights in being referred to as the biggest and best in our land, may serve to prevent others from repeating the same blunder.

The upper floors rest on heavy steel beams, some 15 or 20 feet apart. The pine joists are only two inches thick, and instead of being spaced a foot or so apart, are put close up, one against the next, and nailed through to it, making a continuous solid mass, as shown in Fig. 1. Then above this is one inch of diagonal pine, and on top is one inch of maple; thus making a solid mass of wood 12 inches thick.

The mistake consists in making the ends of the joists meet on the beams and halfway between them, as shown in Fig. 1. Instead of this, the ends of the joists might have been one-quarter of the distance from one beam to the next, as shown in Fig. 2, which would have made a floor *twice as strong* from the same material, and with practically the same amount of labor; or if the floor is amply strong as it was constructed, then it might have been made of joists seven or even eight inches deep instead of ten inches, and still have a floor of equal or greater strength, and saving something like a million feet of lumber in those 10 or 12 acres of upper floors.

Any technical reader will, I think, recognize the cantilever principle in this or the beam free at both ends as against the beam fixed at both ends. Other readers may imagine what would take place if a joist 1000 feet long were resting on beams every 20 feet and loaded all along until it bent into a curve, such as the dotted line in Fig. 2. Note how the curve bows up near the beams and bows down about halfway between them. Also note that there is no tendency to bend at the quarter points *A B C*. So we can take a number of joists, and by joining them alternately at quarter points *B F* and *D H* make a floor from them practically as stiff and strong as though each joist ran the full length of the building.

Another objection to the construction

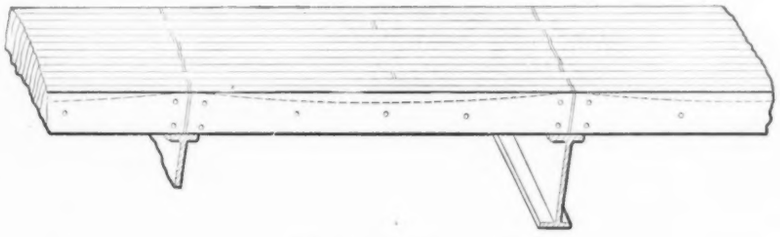


FIG. 1 Factory Floors made wrong

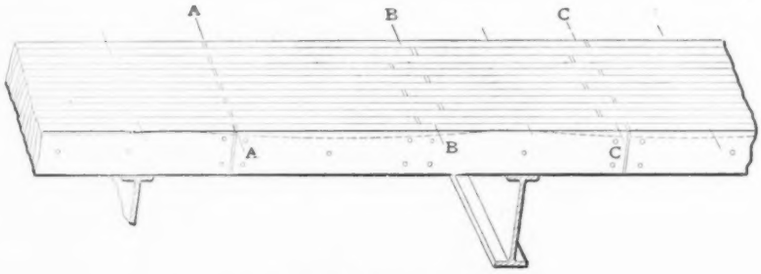


FIG. 2. WHAT MIGHT HAVE BEEN.

shown in Fig. 1, is that when heavily loaded the eighth joist, which runs across the beams, will be broken long before the other seven joists, which end on beams, will have reached their safe limit.

R. J. D.

Tempering Novo Steel with Cyanide.

Do any of the readers of the AMERICAN MACHINIST temper Novo cutters with cyanide? The master mechanic has told me that this takes the life out of the steel. Does it? I don't quite see how it can, but am open for enlightenment. I heat the cutter to a bright cherry, then smear it with cyanide, and let it soak till its "nose begins to run," and then immerse in oil, letting it remain in one place in the bath until cool. I am not particular whether the oil be cold or warm. The scale formed by the cyanide when removed leaves the cutter in fine condition as to cutting edges and size. Is there a better way, that is not a shop secret?

I use cyanide a great deal in tempering tool steel, such as small and delicate dies, bushings and work in which I want to preserve the size and form. I use an oil bath instead of water. The degree of hardness is regulated by letting the object remain still, or moving it around. A large die or cutter should be moved around in the bath on account of the greater amount of heat it retains.

This refers to tool steel only, as Novo cools in its own heat in the bath, to its advantage. Tool steel tempered in this manner, rarely requires drawing.

CARROLL ASHLEY.

Systematic Economy in Making Drawings.

Mr. Summers' article under the above heading at page 546, Part 1, interested me greatly, for which I tender him my thanks, and hope he will take my criticisms in the right spirit. While agreeing with him on some points, I think that he has overstepped the mark on several others, on which I will venture to express my views.

One point is that of the decimal fraction. I have never had any misconception of any dimensions when written thus: $10\frac{625}{}$, that is, putting the whole number in large and the fraction in small type. A dimension thus given does not give any trouble to the shop men even though

the decimal point does not print clearly.

Now keeping in mind the subject, Mr. Summers says that drawings should not be checked, a system which from experience I can say would lead to many more blunders in our drafting room, if it were adopted. The smartest of draftsmen are only human, and are all liable to, and do make mistakes. I am sure there is no appreciable economy takes place through drawings not being checked. As a proof of this I will endeavor to show two ridiculous blunders, which took place a few months ago at a place I was engaged at as a draftsman, and which a checker would certainly have discovered. A 1.5 special-threaded notch nut was required ¾ inch thick. The draftsman must have been disturbed while dimensioning the sketch, and the figure was left rather vague, reading instead 3 inch. This went through without checking into the works, and was made entirely before the foreman erector found out that the nut had been made 3 inches thick instead of ¾ inch. This may seem a bit far fetched to some of your readers, but it is a fact. It is really remarkable what construction a machine man will put upon a drawing, unless it is perfectly explicit.

A draftsman when detailing should show as many views as will be required from the workman's point of view, not his own. The draftsman very often has an image of the required piece in his mind's eye, and does not give the machine man his idea of the piece through a lack of views.

A careful choice of necessary views is essential, as will be seen from the following by no means uncommon error. This piece, a shaft, was required to have a flattened portion, adjoining an ordinary cylindrical part, the flattened portion being dimensioned in the end view. This was drawn as shown in Fig. 1.

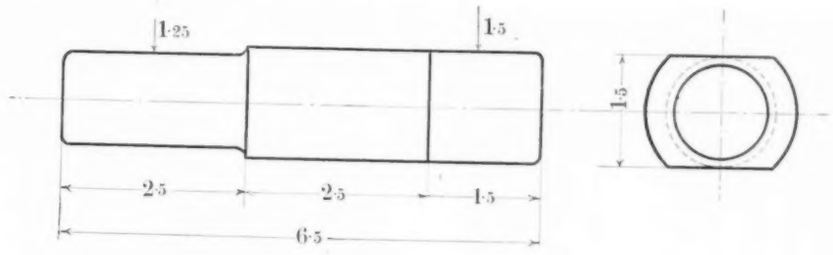


FIG. 1

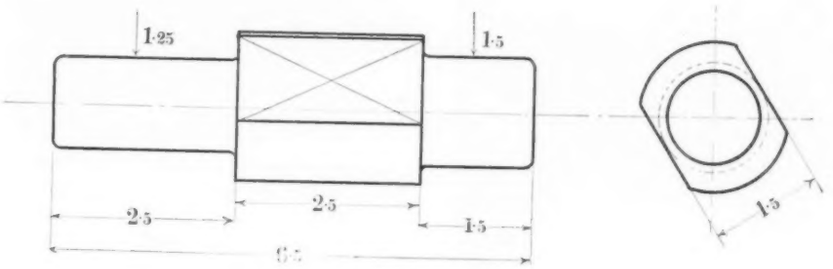


FIG. 2

TWO WAYS OF SHOWING A PIECE OF WORK.

It will be noticed that the flattened portion is the same width across flats as the diameter of the round part. The man noticing this, from the sketch, not from dimensions, at once put it in the lathe and turned it 1.5 inches right along, with a blissful disregard of the end view. He certainly was very slack to make such a blunder, but it is part of a draftsman's duty to prevent such a mistake.

In Fig. 2 you will see the best practice for drafting such a piece.

Another point well worth consideration is the staggering of dimension lines. This prevents errors which might occur through arrow heads being missed.

In checking details, I have found it very useful to place my scale on all the pieces and so catch any error of drafting. A point to be watched, chiefly among juniors, is the tendency to draw a piece half size, and to figure it as it scales.

I hope that these few experiences will go to prove to others the necessity of checking drawings, and so help to obtain that efficiency wherein lies the real economy.

LAURENS.

M——, England.

An Improved Drill Holder.

The illustrations show an improved drill holder. Since making this I find it the handiest drill holder I have ever used in my long experience as a tool maker. Fig. 1 shows it open for use on the bench. By moving *C* toward *a* and then *A* toward *d* the holder closes up like Fig. 2. Every fifth size is numbered so that the ones in between are easily found without the necessity of numbering each one. Fig. 3 shows an end elevation which gives the shape of the links *a*. Springs for retaining the drills are also shown in this view and in the enlarged view, Fig. 4, which is a section through *h h*, Fig. 2. The springs are made of phosphor bronze. A side elevation through *k k*, Fig. 2, is shown in Fig. 5. This holder can be manufactured at very small cost as the whole thing can be made on the punch press, excepting perhaps the eight rivets *a* and the sleeves *c*, but even the sleeves could be made of flat stock curled on the punch press. *E* is the bottom plate. When closed the holder is 1¼x1¼x4 inches.

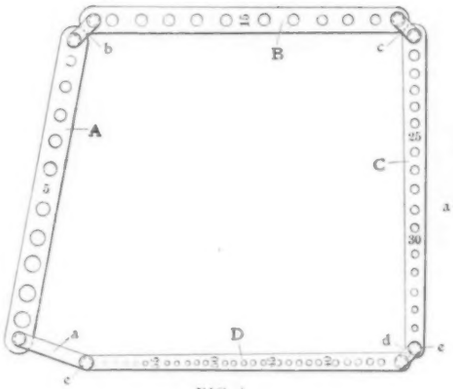


FIG. 1.

FIG. 3.

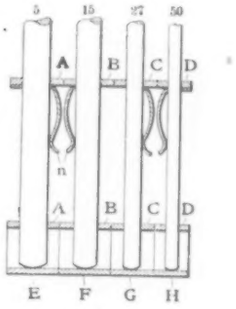


FIG. 4.

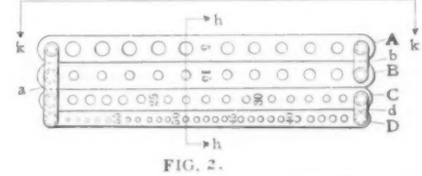


FIG. 2.

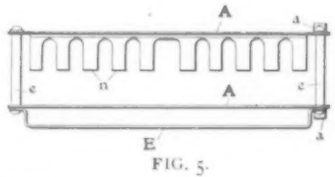


FIG. 5.

IMPROVED BLOCK DRILL.

Soldering and Brazing without Heat.

As a reply to Mr. Jackson's inquiry (by letter) relative to the chemical "calcined tartar"—referred to in my letter at page 652, Vol. 29, Part 1—may interest others, would you kindly publish the following?

I find that calcined tartar is an old name for carbonate of potash and is obtained by calcining hydrogen potassium tartrate, but no one need take the trouble to calcine the tartar as all druggists sell carbonate of potash, and it is a wonder some of them did not know of it under its old name. I got the information on brazing without heat from Spon's "Workshop Recipes."

THOS. R. HASSALL.

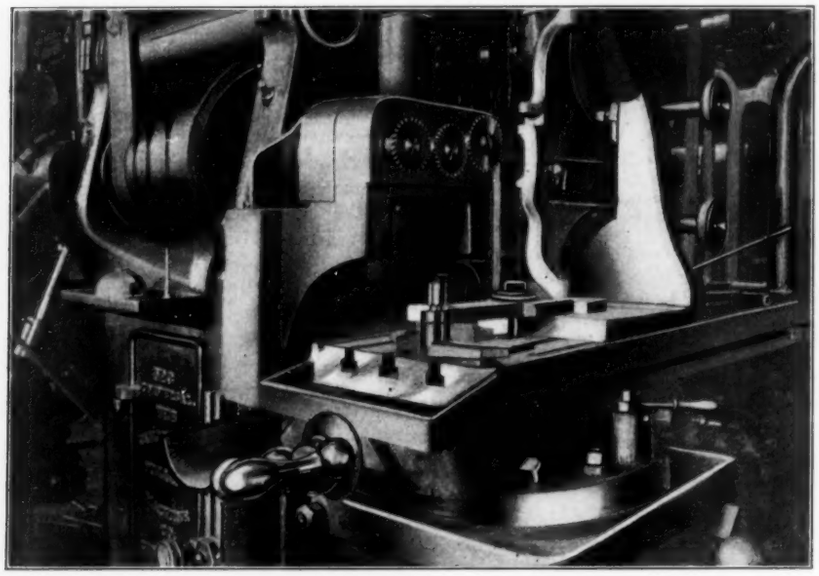


FIG. 1. THREE-SPINDLE MILLING ATTACHMENT.

Two Milling Attachments.

These two attachments have given such a good account of themselves, that they may be helpful to the other fellow.

I have made no attempt to make the bearings in these tools adjustable, because it is not necessary that the life of a fixture in this identical shop, which builds dental chairs, should be very long, on account of the constant changes in the design of the chair.

Fig. 1 shows one of the fixtures attached to a Cincinnati milling machine. This fixture does in one operation what heretofore was accomplished in three, and while the platen has to travel somewhat farther, the feed has not been decreased, so that the time saved is about two-thirds on each piece milled.

In Fig. 2 the cutters *A* and *B* and the slitting saw *C* are shown mounted on shafts connected by gears at *D*. The central shaft is driven by an interlocking joint at *E*. *F* is the tapered driver which fits the spindle of the milling machine. The gears *D* are secured to their shafts by Woodruff keys and are 8 pitch and 23 teeth.

The cutters *A* and *B* are made of Novo steel. *A* is 0.031 inch smaller than *B*, and the saw is 0.0625 inch thick. The cutters mill an opening in the back of a dental chair, cutting both top and bottom bearings in one cut. *A* does the roughing and *B* the finishing. The saw cuts a slit still deeper into the work, thus providing a take up for wear in the slide that works in the chair back. Now in this attachment there is apparently no adjustment; however, when the cutters have worn down thin, washers may be placed behind the finishing cutter *B*, thus throwing it out of line. But as yet no adjustment has been necessary.

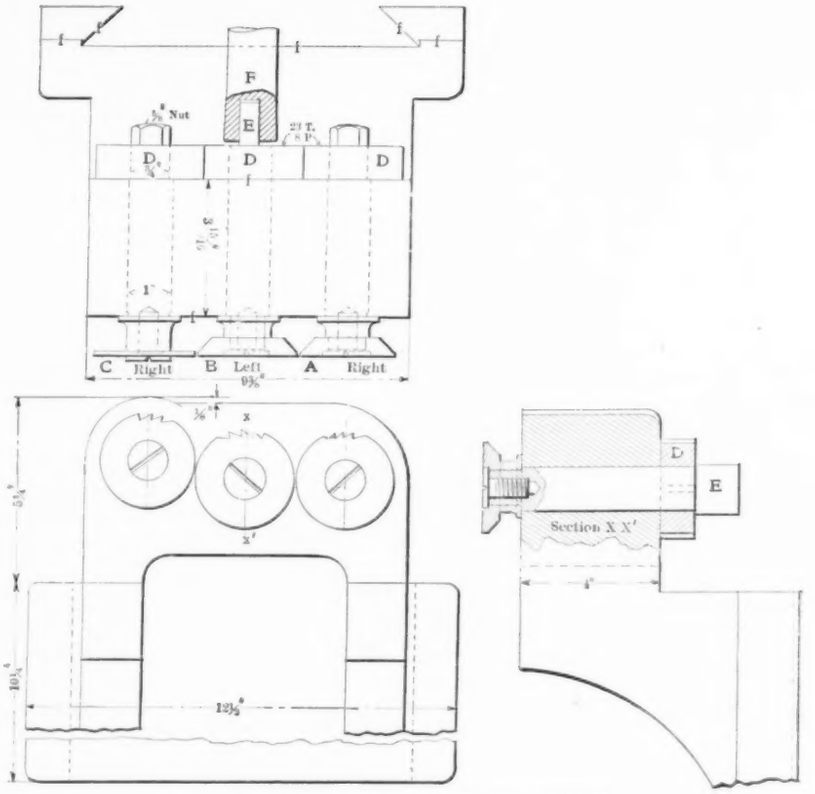


FIG. 2. THREE-SPINDLE MILLING ATTACHMENT.

Fig. 3 shows a drawing of a duplex milling fixture. I made the two shafts work as separate units in cast-iron holders which are hinged together. This design admits of an adjustment of the cutters when sharpened. It will be seen that when the hinged part is attached to the collar that fits the steady arm of the miller, the whole fixture can be attached and removed as a single unit, without disturbing the alinement of the cutters. The lower or driving shaft is made long enough to enter the taper hole in the spindle of the miller as seen in Fig. 4.

The limit of adjustment to this fixture is governed by the diameter of the gears, and I had the cutters made to a size that would admit an adjustment of 0.062 inch before the gears meshed tight. This would seem to give the cutters a chance to chatter and to obviate this I expected to have to make the secondary gear of composite form; that is, two gears in one, so one-half could be turned just a little and thus take up the slack; but upon testing the fixture on a coarse feed, there was not a tremor other than that of the miller

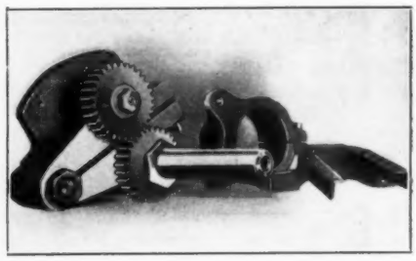


FIG. 4. DUPLEX MILLING ATTACHMENT.

itself. I believe the overlapping of the large cutters causes it to work so free, as there is no time during the cut but what the teeth are continuously engaged in the work. This fixture does in one operation what was formerly done in seven.

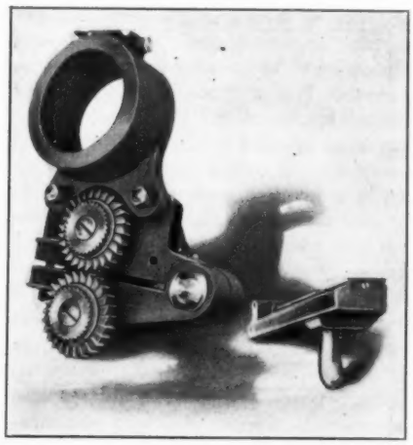


FIG. 5. DUPLEX MILLING ATTACHMENT.

Fig. 5 shows another view of the attachment, together with the gear guard and the piece it is designed to mill.

CARROLL ASHLEY.

A Shortcoming of the Technical Graduate.

When I see anything such as Engineer writes at page 86, it arouses my interest at once, for I have a small boy for whose future education I shall have to provide, and his bent is decidedly mechanical. At first glance it struck me that Engineer was about right, but now I am not so sure. I doubt if it would be good policy for these schools to train their boys to be much better over their drawing boards than they are. I doubt if the schools can obtain the men who can tell at a glance whether a drawing is fully dimensioned or not; I doubt if more time should be given to school education than is now given; and I doubt too if Engineer has had a fair run of technical men to judge from.

I have had only seven green technical men work for me. Two were supposedly good men, the other five were tail enders, who worked for me only while they were hunting up good jobs. Of the whole lot there was not one that failed to come up to the scratch and make in a few weeks as good a draftsman as I could use. I remember that the worst one of the lot made me some patent-office drawings that went through without a word, and this after a patent lawyer, a graduate of the same school, told me that no man not specially trained for the work could make a drawing that would pass inspection. These boys all had their faults, most notably a bashfulness about putting on ink and a tendency to spatter on dimension lines without thinking how they would be used, but it took only a few weeks for them to get into line. What is the use of the schools doing anything more for them?

I do not think I shall send my boy where they intend to teach him any trade. I believe in trade schools, but I want my boy to become an engineer. If he cannot make an engineer I will put him in a trade school and let him do what he can from that way of starting. I expect him to get a grounding in the underlying principles of engineering, to get a fair education in a general way, to learn to write better English than I can teach him, to learn to be a gentleman and to take some of the hard knocks of life gracefully. If he gets these things I shall expect him to turn to any branch of engineering he may think he has a liking for, and, beginning at the bottom, I shall expect him to work his way up through much faster than he could if he had only gone through the shop. This is the same thing as saying that if the school will sharpen his wits along lines tending to the mechanical, as thoroughly as the colleges do for their students along general lines, I shall feel that the money has been well spent. I do not see any object in sending him through a college where they will only teach him to think in Latin or Greek, when I realize that an equally good mental training can be had and also a fair amount of useful information gathered with no more effort or time. If he should come out of school a specialist, especially in drafting, I should feel that something was wrong. It may be good for these boys to take a short job in some drafting room while they are looking around for something better to do, but I have seen so many who have suffered by staying in the drafting room too long that I feel like putting in a word of warning.

Some little time ago I was approached by a young man who wanted to know how he could get out of the drafting room. He was a total stranger to me, and I am sure I do not know why he said anything to me about it, unless it is that people seem to think that I am a sort of public recipient of hard-luck stories. Inquiry developed the fact that he had graduated well at one of the leading schools, had had a chance to go into the drafting room of a large, well known shop and had taken it. He had struck their gait easily and was making $3 per day of eight hours and had, so he thought, reached the limit. Like the method of resuming specie payments, I told him that if he wanted to get into a shop the way to do was to go into a shop, take what he could get and work up as fast as he could. And there was the trouble. About a dollar and a half a day was all he could get inside a shop, and he was married and had two children. He simply could not do it. There is a lesson in this for any young fellow who thinks the best way up is through the drafting room. There is a chance, but it is not half so good as through the shop. No man who has had shop experience will believe that a man without it is of any use in a high position in engineering work, and most of the men who have the choosing of subordinates are shop educated. They appreciate the advantages to them of technically trained men and they recognize their shortcomings, and they have a shop which is usually just the place to make good those shortcomings. Drafting ability cuts almost no figure with them, shop ability everything.

The problem of getting instructors in these schools must be a troublesome one, at the salaries they can pay, and if they were to try to get instructors who "can

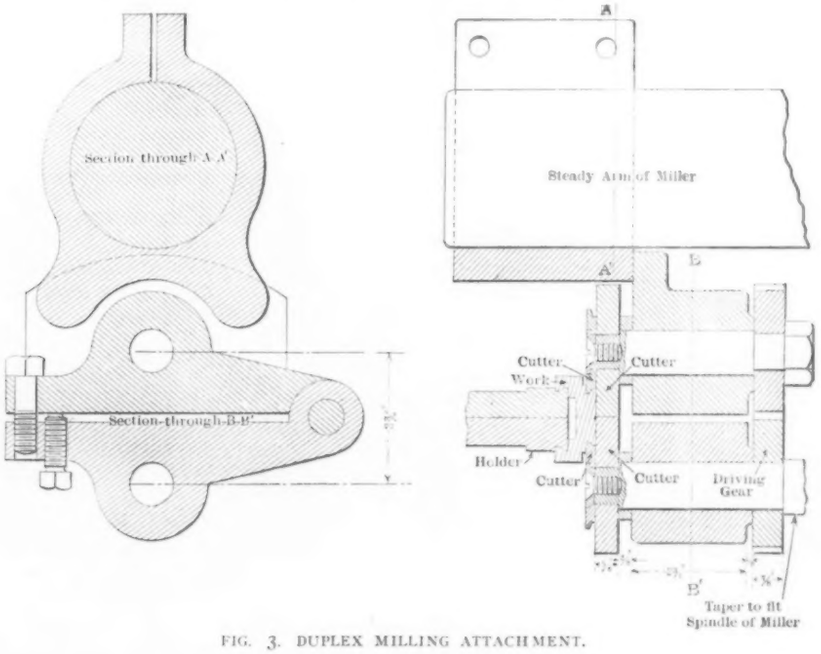


FIG. 3. DUPLEX MILLING ATTACHMENT.

glance at a drawing and instantly locate a missing dimension" I am afraid they would come out shorter at the end of the year than ever. It must take a skilful man indeed to do this. I have had to use a drawing board for twenty or twenty-five years, and there is nothing that I find so difficult as to take another man's drawing and say whether it is all there or not. It means the conscientious going over of every line and every dimension. It is a tedious job that is terribly irksome to any man who is capable of it. No, please don't try to have these schools put anything more into these boys' heads. They are jammed full nearly to bursting now when they come out, so full that they have to forget something before they can absorb anything more. ENTROPY.

Throating Dies with an End Mill.

The jig shown in sketch has proven itself efficient for its purpose—that of throating dies for bolt cutters. In the place where the writer works this job usually was done with the file, but now the apprentice boy using the jig does such

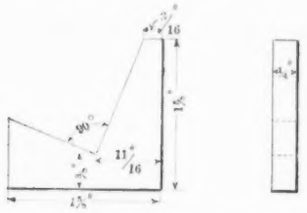


FIG. 1 Jig for Throating Bolt-Cutter Dies

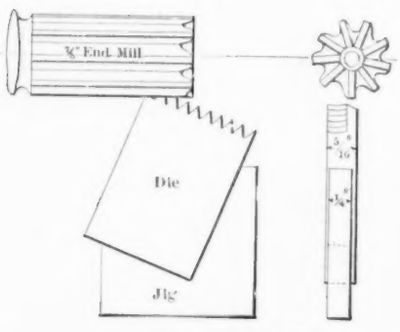


FIG. 2 The Jig in Use

work on the milling machine. Fig. 1 shows the jig with dimensions. Fig. 2 shows the die placed in the jig, which is then held in the vise of the milling machine. The end view in Fig. 2 shows the cutting edge of the die set in advance of the end-mill center line, which gives the required clearance. As the die is 5/16 inch thick, it will be held firmly; the jig being only ¼-inch thick, the latter merely serves to hold the die at the proper angle while being clamped. It is well to have the dies belonging to one set of equal length. After feeding the first die vertically to give the proper amount of throat, the dial can be set at zero, which setting will then answer for the remaining dies.

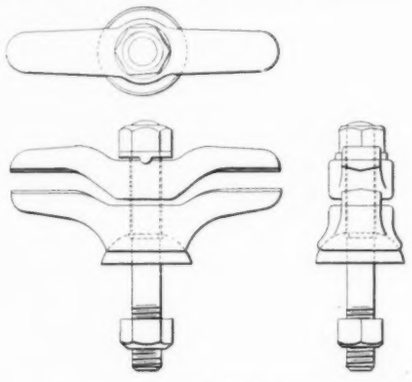
After the dies are hardened the cutting side is slightly ground on the emery wheel, which makes it possible to see the temper colors, and also gives a sharp cutting edge. A. B. GINNER.

Machining Fly-Wheels in the Lathe.

We had a contract for a large number of fly-wheels a few years ago. They were 22 inches diameter, the rims were 2¾ inches square, and one end of the hub was a flange 4½ inches diameter and ½ inch thick. The bore was 1¾ inches.

The rim had to be smooth turned all over and up to the arms on the inside, the flange faced on both sides and turned to gage. As we expected to get out a large number of other wheels of a similar nature, we felt that it was well worth an effort in the way of some special appliances.

We made a casting that reached across the carriage of a stiff 36-inch lathe, on the left-hand side of the regular cross slide, bolting it solidly at the T-slots. On the front end of this casting we had a circular seat the same diameter as the base of the compound rest which we fitted to it. This made a species of "full-swing" rest.



LATHE FIXTURE FOR HOLDING FLY-WHEELS.

In the place from which we took the compound rest we secured a suitable block having a T-slot, to which another tool post was fitted.

In this way we were able to run two tools at once on parts of the rim, cross-feeding the left-hand one by hand.

The accompanying sketch shows the rig we made to hold the wheels. A three-arm spider was first made and screwed on to the spindle, on which were secured the clamping devices shown. A ⅞-inch bolt was used and the spherical part held securely in position, using as a shoulder a wire snap ring sprung into a groove in the manner indicated. By the use of this rig we were enabled to secure a good hold on every arm without springing the wheel, as the spherical feature gave us a three-point bearing. This, I think, will meet with the approval of Professor Sweet, whom we all know to be an ardent advocate of three legs on lathes, jigs, etc.

We carried a floating reamer on an arbor projecting from the tailstock spindle.

We put on the best double belt we could buy, and after a day or two the operator was making chips at a rate that threatened to bury the lathe. He was turning wheels out at the rate of eight per day, which seemed very satisfactory to us.

A few days after getting started on the job Mr. Brown, our mechanical head man, happened to drop in at a neighboring mechanical institution and while there was introduced to the representative of a machine-tool firm that makes a specialty of vertical boring mills. Said he: "I am very glad to meet you, Mr. Brown, as I was on my way over to your place to show you how to save money on turning your fly-wheels." Brown replied that, while his firm was doing fairly well along this line, they were always interested in improvements. Half an hour later the traveler came in. Brown was down at the forge engaged in tempering a delicate milling cutter, so was not at liberty to greet his visitor, who soon found and entered into conversation with the man who was turning the fly-wheels.

A few minutes later, when Brown approached, he said: "Mr. Brown, I did not come here to receive an education, but I have learned something." "What have you learned?" "It is my business to sell machines for turning fly-wheels, and I manage to keep pretty well informed as to what others are doing in this line; but, considering the amount of work you are doing on those wheels, you are turning them out faster than anyone else that I know of, and it is useless for me to attempt to sell you a mill." This was very gratifying to Brown, providing he was not giving him "taffy," but there seemed to be no reason for this. After a short stay our visitor departed, and the lathe man told Brown that he had "stuffed him a little." "How much?" "Oh, I told him I was turning out nine a day, and once in a while ten."

Today there are machines built that will turn out possibly twelve or fourteen 48-inch fly-wheels per day, but there is usually much less work done on each wheel; further, ours was nothing more than a good ordinary commercial lathe, and not a machine designed and constructed especially for fly-wheel work—

so I still think we were doing passably well. CHAS. A. TRASK.

A Duplex Lathe Tool Holder—A Hand Press—An Adjustable Milling Cutter.

Figs. 1 and 2 show a duplex tool holder that makes it possible to take a roughing and finishing cut at the same time.

We have a cast-iron cylinder that has on its periphery four ribs. This cylinder, indicated at *A*, Fig. 1, is turned on centers in a lathe. If the outside were plain the duplex tool would not produce a perfect surface, inasmuch as the irregularities of the casting would be followed by the cutting tools; but the ribs being only an inch and a quarter wide and the distance from the cutting edge of one tool to the edge of the other being greater than the width of the rib, the roughing tool passes each rib before the finisher begins cutting

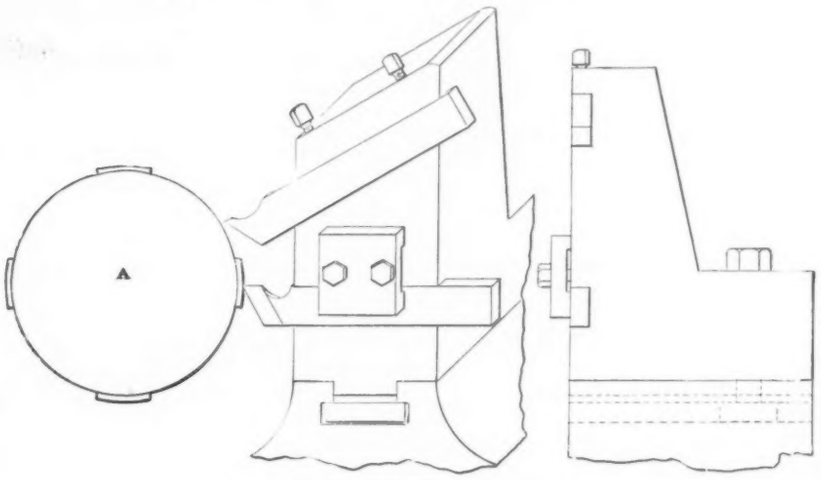


FIG. 1. DUPLEX TURNING-TOOL HOLDER.

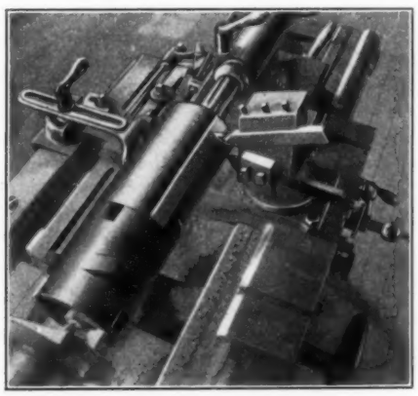


FIG. 2. DUPLEX TOOL HOLDER IN ACTION.

In other words the action of the finishing tool is in no way influenced by any irregularities that the rougher may encounter. This arrangement of two tools makes it possible to use either as a rougher. The finishing tool is set about one-sixteenth behind the rougher. The holder is made of gray iron; the upper tool is retained by set screws and the lower by a clamp at the side. The photograph Fig. 2 shows the duplex tool in action.

We have no punch presses in our shop, but as there are a number of parts of the dental chair which we build that can be made of sheet metal, I hope to educate the master mechanic toward their introduction.

I designed a small hand press that makes an oblong perforation in a metal plate and at the same time bends a lip downward at right angles. This press is shown in Fig. 3.

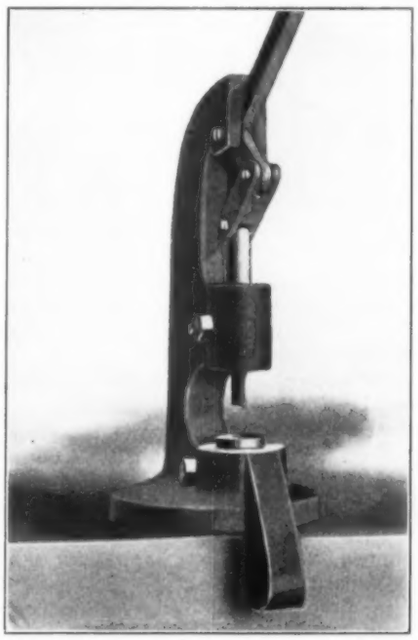


FIG. 3. A HAND PRESS.

We have occasion to do a lot of milling, making a cut like the opening in the piece Fig. 4. The cut is not wide enough to introduce a duplex cutter into it and using a cutter wide enough to take both bevels at once necessitates the making of new cutters quite frequently, as after being ground it is apparent that a narrower slot would result. An inserted tooth is not practicable so necessity led me to design the cutter shown in Fig. 5. A tool-steel shank is turned as shown and threaded to receive a collar like *B*. In the periphery of the collar is drilled a hole for a spanner wrench. The cutter is made of Novo steel, in one piece, tapered as shown both outside and in. After turning and milling the teeth it is cut into three sections and a key way cut in each.

Now to make the cutter larger the thimble or collar *B* is unscrewed a trifle and the retaining screw *C* turned inward the desired distance to move the three sections along on the tapered end of the shank. *B* is then turned until it clamps the three sections fast, thus making a solid cutter.

I think I hear someone say I have lost the strength of my cutter, as only one tooth in each section will be cutting. Theoretically this is true but practically I have sufficient teeth operating not only to take this cut but to allow me to increase my feed should I wish to crowd the work; in the first place very few cutters run true with the spindle and a sectional cutter of this design may run out, so there will be just so many teeth cutting anyway. But

FIG. 4

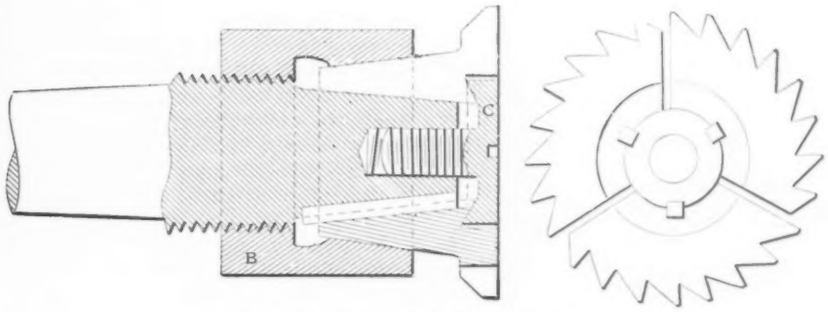


FIG. 5. AN EXPANDING MILLING CUTTER.

let us suppose it runs true; the adjustment needed for this identical job is so slight that it is a practical cutter nevertheless. CARROL ASHLEY.

Eliminating the Tracer—Better Not.

I was much interested in the article called "Eliminating the Tracer—Suggestions Regarding the Making of Blue Prints," at page 123. The gymnastics through which drawings are put in order to get a desired print is indeed attractive reading. But the matter of costs and practical application of the methods, I think, will not be attractive.

One of the points to be considered, aside from the making of blue prints from a tracing, is the advantage of having all drawings on a certain prescribed sheet as to size, foot-notes, margins, bills of material etc.; for in a large concern where the number of drawings runs up into the thousands, some uniform standard has got to be adhered to in order that the files can be handled efficiently and in order that the bills of material and the other information which are sometimes taken separate from the drawings, for different files and usages, may be in the proper place on the drawing for separate blue printing, and may have the same conventional specifications.

In making a pencil drawing, it many times occurs, especially on layout and general drawings, that the draftsman is compelled to overstep the exact prescribed size of a sheet upon some one margin by an inch or so, this caused by the fact that he can never know the exact size or shape that all the views of the drawing will take; hence his drawing or direct copy of same is not fit for a standard file. In first-class drawing rooms, where standard methods of specifying material are used and where they are particular about uniformity in size and form of letters and figures, the tracer is practically indispensable for he is trained in quickly and neatly forming his letters and can be used in the place of the much more expensive draftsman for putting in the bill of material, forms, and notes—blank bills being furnished the draftsman, who fills them out and pastes them on his drawing, instead of having to take the time to print them in.

Another feature which makes the tracer very desirable is that he can give proper weight and size to full lines, broken lines, and center lines and thus make the drawing stand out much more clearly than could possibly be gotten with a print from a pencil drawing made by a draftsman who should have other things on his mind than the size of his lines and the exact placing of his letters.

Referring to the use of white translucent paper, I cannot see how it could be used in layout work where a great deal of erasing and working over a drawing is necessary before the final design is decided upon. In this case a hard pencil is necessarily used, because the constant working over would smear the soft-pencil lines, and the hard pencil makes an unremovable indentation which would cause more or less of the erased lines to show up in the print, thus seriously complicating matters.

The making of a "Brownie" is a rather slow process, and quite expensive, and as a rule the prints from them are ragged and indistinct.

It appears that in any large place where the volume of work is enormous and certain standards have to be adhered to in the making of drawings, this causing a good deal of work such as putting in standard forms, etc., and where these forms must be so placed that they can be rapidly duplicated separate from the drawing, that a tracing is almost indispensable. And of course as to the matter of changes on drawings a tracing is the most satisfactory, no chemicals being needed to remove undesired lines, and the erasing of lines not effecting the replacing of other lines. F. H. NEELY.

418 Rebecca Ave., Wilkinsburg, Pa.

Cast-Iron Beams.

The figures given by C.41770 have a very familiar look. In my text book the formula is given as $M = S_t \frac{I}{c}$. S_t is the ultimate strength of flexure of the material. For cast iron it is given as 38,000 pounds per square inch. I is the least moment of inertia. A table is given with formula for finding the value of I for a number of given sections. This table also shows the position of c for the given sections. c is the perpendicular distance from the neutral axis to the outermost fiber. No mention is made as to whether this "outermost fiber" is to be in tension, or to be in compression; neither is anything said as to whether it is to be on the top or on the bottom. In the illustration given it is shown as being on the top. This would be all right if always used for a cantilever. On the page following the one giving the moments of inertia is one giving the maximum bending moments. The various kinds of beams are illustrated and an inspection of them shows that if a T section of beam is used with the same side up in all cases the outermost fiber will be in tension on part of them and in compression on the rest.

Immediately following the formula given above is this declaration, "The values of I and c depend wholly upon the size and form of the cross-section of the beam, and S_t is the ultimate strength of flexure of the material."

How, from these statements, is a young draftsman who refers back to them when needing to use a cast-iron beam of T section to understand that c is the distance of the outermost fiber *of the side under tension* from the neutral axis? Having no "previous experience" he has to rely entirely upon the statements of the books that are within his comprehension, and with which he is familiar.

With cast iron at the head of the table giving the value of S_t, how is he to know that the formula as given does not apply? With the illustration of the section with position of c on it before him, how is he to know that it is *hight minus c* that he should use in some cases instead of c?

The practical man is not apt to be misled by such things in the lines with which he is familiar, but the knowledge of them often makes him afraid to trust what appears to be the plain statement of the books in the things with which he is not familiar. C 47196.

International Maritime Exposition at Bordeaux in 1907.

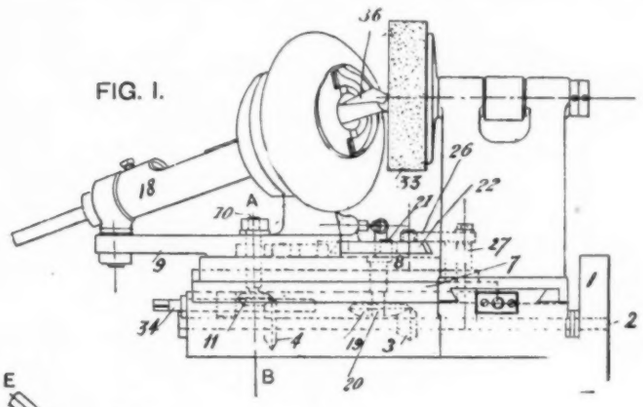
An international maritime exposition in celebration of a century of steam navi gation, will be opened in Bordeaux on May 1, 1907, under the auspices of the League Maritime Française, and the official patronage and aid of the French Government and other organizations. The exposition, which will last about six months, will be opened to all countries and will receive all industrial, agricul!tural or artistic products pertaining to maritime affairs. It is intended that each foreign country participating shall accredit to the commissioner general a special commissioner to represent its exhibitors. The exposition will be constituted into a bonded warehouse, consequently the products exhibited will be exempt from verification, custom-house and octroi taxes.

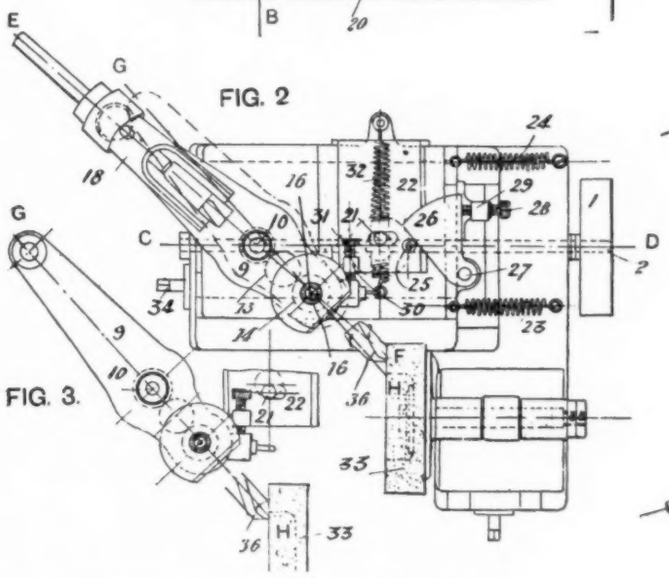
Information regarding the rentals for space may be obtained from the commissioner general at Bordeaux, and requests for admission must be addressed to this official prior to February 12, 1907, or dissatisfaction may result and requests may be refused. Exhibitors who may require water, gas, electricity or motor power must state this fact on their application for admission, giving all necessary details as to the speed required for each of their apparatus. The price of power will be fixed at the lowest possible rate.

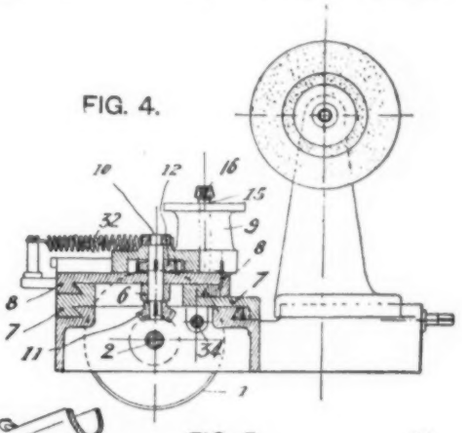
The general classification contains 92 different classes, divided into 17 groups, as follows: Marine history and fine arts; instruction; charts and instruments; navigation and commerce; navy; materials for construction; motor machines and propellers; fittings and apparatus; automobile navigation and boats of all types; aeronautics; port and harbor works; sea and river fishing; hygiene, salvage and sports; ships' provisions, food; various industries; commercial relations of Bordeaux with the colonies; social economy, works of mutuality and charity. The Commissioner General is M. E. Bertin, 26, cours du XXX-Juillet, Bordeaux, France.

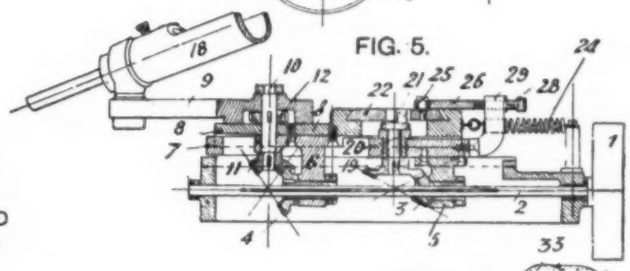
Mayer's Twist Drill Grinder.

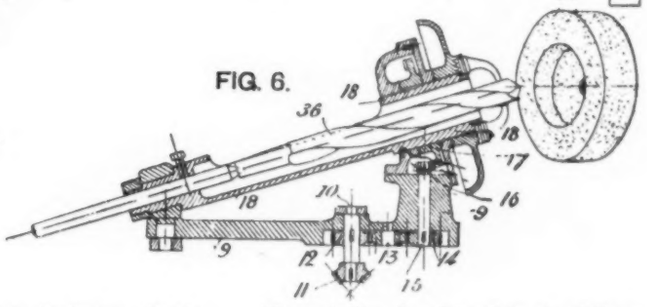
A machine for automatically grinding twist drills has recently been devised by G. M. Mayer, of Offenbach-on-Main, Germany. It is shown in the accompanying illustrations, Fig. 1 being a side view, Fig. 2 a plan view showing the drill adjusted ready for the commencement of the grinding operation, Fig. 3 a plan showing the drill at the ends of its circular movement, Fig. 4 a section on line A B of Fig. 1, Fig 5 a section on line C D of Fig. 2, and Fig. 6 a section of drill holder on line E F of Fig. 2. The principal features of the arrangement are the means employed for enabling the angle to which the points or lips of the drill are ground as well as the amount of the "backing" to be regulated whilst the grinding is being effected.











By means of a pulley 1 rotary motion is imparted to a shaft 2, and consequently also to toothed cone wheels 3 and 4 which are slidable thereon. Both the wheels 3 and 4 are provided with slidable sleeves which are rotatably carried in bearings 5 6, which latter are fixed or screwed to two superposed supporting plates 7 8, the bearing 5 to the lower plate 7 and the bearing 6 to the upper plate 8. The supporting plate 7 is provided with a screwed spindle 34, whereby it may be moved in a horizontal direction and the plate 8 is also adapted to be moved in a horizontal direction, and is provided with springs 23, 24 which tend to draw the plate rearwardly. The plate 8 is provided with a spindle 10 on which, and supported by the plate 8, an arm 9 carrying the drill support or holder is pivotally mounted. On the spindle 10 two wheels are mounted, on the lower end a conical-toothed wheel 11, and on the upper part a toothed wheel 12. The wheel 12 serves to transmit the rotary motion of the wheel 11 to wheels 13 and 14. The wheel 14 is keyed on a spindle 15, which carries at its upper end a cone pinion 16. This pinion drives a toothed wheel 17, which is fixed on the drill holder 18 and serves to rotate the latter. In the center of the drill holder 18 the drill is fixed, the arrangement being such that the drill will be rotated with the holder whether either the plate 7 or 8 is moved or whether the arm 9 is rotated about the spindle 10.

The cone pinion 3 gears with and rotates a cone wheel 19 which is mounted on a spindle 20. The spindle 20 is rotatably carried by the plate 7, and its upper end is provided with a disc having a pin 21 eccentrically mounted thereon. This pin engages in a slot in a plate 22, so that by the rotation of the spindle 20 the plate will be reciprocated backwards and forwards. The plate 22, slidable on the plate 8, and the plate 8 will be drawn or pulled rearwardly by the springs 23 24 until a roller 25 comes in contact with a segmental plate 26. This plate 26 is rotatably mounted on a bolt 27 which is fixed on the supporting plate 7. Further, the plate 26 rests against a regulator screw 28, by means of which the said plate may be adjusted. The screw 28 is carried by a horn 29 also fixed on the plate 7. At one side on the plate 22 there is a lug 30 through which a second regulating screw 31 passes. Against this screw 31 the enlarged part of the arm 9 is drawn by means of a spiral spring 32. By means of the screw 31 the angle of the arm 9 relatively to the face of the grinding wheel 33 is regulated.

The grinding is effected in the following manner: The drill is slowly rotated around its axis whilst it is held at an angle to the grinding disc, about as shown in Fig. 2. The spindle 20 together with its eccentric pin 21 is simultaneously rotated, the relative proportion of the wheels which rotate this spindle being such that when the drill makes one revolution the spindle 20 and its pin 21 have made two revolutions. In Fig. 2 the drill is shown adjusted for the commencement of the grinding operation. By the rotation of the pin 21 the plate 22 is moved so that the regulator screw 31 partly rotates the arm 9 around its spindle 10. By reason of the movement of the plate 22 the springs 23 24 are enabled to draw the plate

8, together with the drill holder, to some extent in a rearward direction, so that the roller 25 is always in contact with the sloping or angular edge of the plate 26, whereby the angle of the drill relatively to the grinding disc is so changed as to cause the necessary "backing" to be effected. When the eccentrically-placed pin 21 has made half a revolution the axis of the drill will have been moved from the position E F shown in Fig. 2 to that indicated by the line G H, the drill itself having rotated to the position shown in Fig. 3.

It will thus be seen that the surface ground on the half of the drill is of spiral form, the cutting edge being ground to an angle which the line E F makes with the face of the grinding disc, and this angle, as the drill slowly rotates is gradually altered until at the end of the grinding stroke the axis of the drill will make an angle indicated by the line G H (as shown in Fig. 3) with the face of the said disc.

The length of the slot in the plate 22 is such that when the position shown in Fig. 3 is reached the pin 21 will prevent the springs 23 24 moving the plate further. The pin 21 by moving the plate 22 also moves the plate 8 together with the drill holder and drill away from the grinding disc, and also the roller 25 from the plate26. This continues until the drill has made a further quarter of a revolution, and the pin 21 consequently a half revolution. After this, the grinding of the other half of the drill or the other cutting edge will be effected in the manner already described.

It will be seen that the screws 28 and 31 are of considerable importance to the proper grinding of the drill; the former of these screws by causing the angle of the sloping side of the plate 26 to be changed determines the amount of the "backing," and the latter 31 determines the angle to which the cutting edge, relatively to the axis of the drill, will be ground. Both screws are adjustable while the grinding is proceeding. Further, by reason of the cutting end of the drill being pressed against the grinding disc by the spring 32, the said end may, by merely pushing against the free end of the arm 9, be moved away from the grinding disc to permit its being inspected.

Marine Applications of the Curtis Turbine Steam.*

BY CHAS. G. CURTIS.

The first vessel to be propelled by steam turbines of this type, and the first vessel of any kind to be fitted with twin shafts and screws and twin turbines independently controllable and reversible, was the yacht Revolution, built in 1902. This yacht had a length of 140 feet on the water line, beam of about 17 feet, a draught of 7 feet and a displacement of about 200 tons, and was provided with two independent turbines of about 1,200 H. P. each, turning outward and designed to run between 650 and 750 revolutions under full speed conditions. The turbine casing, including the reversing mechanism, was only 5 feet 10 inches in diameter and about 4 feet long. The turbines were not designed to show any remarkable economy, but were expected to consume about the same amount of steam as an ordinary triple expansion engine under the usual conditions of service. This yacht was put into commission in the spring of 1902 and was kept in commission and used for exhibition purposes continually, with the exception of two months during one winter, for a period of a year and a half.

The practical operation of the turbines was in every respect most satisfactory and convincing, neither one ever having required any repairs of any kind, and the steam consumption was shown by torsion shaft test to be substantially equivalent to that of the ordinary triple expansion engine under average working conditions. The boat, however, failed to develop the speed anticipated, and it was a long time before we could find out why this was so. The impression seems to have got abroad among marine engineers that the failure of this boat to show a speed consistent with the high power provided was in the main due to a failure of the turbines to develop the necessary H. P. Such was not the fact. One of the turbines when driving the screw in the ordinary way, was subjected to a very careful torsion shaft test by Prof. James E. Denton, who, with Prof. Webb, devised and worked out an ingenious and accurate method of measuring the angle of twist of a specially calibrated length of torsion shaft introduced into the line shaft for this purpose. The tests showed that the turbines developed the full power expected, and that the steam consumption was about 17½ lbs. per I. H. P. The results are given in the above table:—

POWER AND ECONOMY OF ONE TURBINE

Number of steam passages in use.	Revolutions per minute.	Brake horse-power or horse-power delivered to propeller.	Indicated horse-power of equivalent piston engine.	Dry steam per hour indicated H.P. of equivalent piston engine.
1	2	3	4	5
4	748.0	1,096.0	1,267.0	17.46
3	672.8	761.6	898.7	18.14
2	596.6	467.1	572.0	19.12
1	452.5	192.3	269.5	21.34
1 throttled	265.3	95.7	146.2	24.67

The failure to get the expected speed, viz: 21 to 21½ knots under conditions where the boat actually showed only about 18 knots, furnishes another illustration of how easy it is to "fall down" in an engineering matter of this kind, even when the best knowledge and talent are availed of. In order to insure success we not only had the vessel designed by a well known firm of yacht designers and builders who had previously built a yacht which was and still is the fastest yacht in this country, but we had the yacht's model tested in the Government testing tank in Washington, and the screws were designed by a very distinguished authority in this country. Several sets of screws were built for the boat, the last set having a diameter of 4 feet and a pitch of 4 feet and having thin blades of well known form. From what is now known of the action of propellers of this character and from the fact that the turbines did develop the power expected, we have been led to conclude that the trouble with the Revolution was in her model, which, in the afterbody is very bad, her floor not being drawn out aft far enough. This view is confirmed by the best marine architects whom we have consulted about the matter and who have observed the wave action of the boat, which is very excessive, even at a speed of only 18 knots.

The reversing and manœuvering capacity of the Revolution was even better than anticipated, and was very satisfactory. In a manœuvering test made by a Board of the Navy Department it was found that when going ahead at full speed (about 18 knots) the boat was brought to a standstill in the water in 32 seconds after the engine room telegraphs were thrown over. The boat was used extensively about New York Harbor for a year and a half, and her reversing power was called into play to the utmost very frequently, but it never failed to respond with the necessary power, and during the whole period of her use as a "demonstration" no trouble of any kind whatever was had with either of the two turbines.

Some time ago the Fore River Shipbuilding Company of Quincy, Massachusetts, at the instance of its very able and progressive president, Admiral Bowles, and after an investigation into the comparative merits of the two types of steam turbines available for the purpose, entered into contracts for the construction of two large vessels to be equipped with twin independent Curtis turbines, which vessels, together with the turbines, the Fore River Company is now building. One of these is the United States scout

* Read at the thirteenth general meeting of the Society of Naval Architects and Marine Engineers.

cruiser Salem and the other is the Southern Pacific steamer Creole, particulars of which are as follows:

	Salem	Creole
L. W. L.	420 ft. 0 inches	415 ft. 8 inches
Breadth	46 " 8 "	53 " 0 "
Draught	16 " 9½ "	25 " 0 "
Displacement	3,750	10,160 tons
Horse-power	16,000	8,000
Speed	24 knots	16 knots

In both vessels there are two shafts and two screws with complete independent turbines on each shaft. In the case of the Salem the proposed revolution of the screw at 24 knots is 350; in the case of the Creole somewhere between 225 and 275. The space occupied by the turbines fore and aft (including the reversing mechanism) is only about half that occupied by the equivalent triple or quadruple expansion four cylinder engine and the weight is considerably less. In the case of the Creole the weight of the two turbines is, roughly speaking, about half of that of the equivalent quadruple expansion engine. The total saving in weight of the engines, shafting, propellers, etc., is very considerable. Each turbine is in the form af a drum shaped shell, built up in sections, having an outside diameter of about 11 feet and an overall length of about 14 feet. Each turbine comprises 7 stages for going ahead and two stages for reversing. There is no end thrust due to the pressure of the steam in the turbine itself and the propeller thrust is taken up by the ordinary thrust block external to the turbine.

During the past summer the Vulcan Shipbuilding Company of Germany completed a turbine vessel called the Kaiser, which is fitted with two shafts and two independent turbines of this type. The turbines were built for the Vulcan Works by the Allgemeine Elektricitats Gesellschaft of Berlin, who are licensees under the Curtis Turbine Patents, and were designed by and built under the very able direction of Mr. O. Lasche, the technical director of the turbine works of the Allgemeine company. The performance of these turbines and of the vessel on her trial trip was admirable, and reflects great credit upon Mr. Lasche and his associates, and also the designing engineers of the Vulcan Works, who assumed the responsibility of getting efficient screw action under the unusual conditions. The guarantees were intended to represent the performance of a first class 4-cylinder triple expansion engine and the ordinary slow turning screws which necessarily have a somewhat higher efficiency than the comparatively high revolution screws requisite for turbine propulsion. The actual figures guaranteed were a speed of 19½ knots, and a consumption during a 6-hour run of not over 4,700 kgs. of coal per hour, including all auxiliaries. Progressive speed trials were had up to 20.46 knots, the propellers turning at 655 revolutions per minute. During a 6-hour run 20 knots was averaged on 4,060 kgs. of coal per hour. We have not yet ascertained positively what the H. P. developed was, but we understand that the shaft H. P. was measured by the use of a torsion shaft, and we understand on good authority that the indicated H. P. of the engines for the ship at 20 knots is estimated at 5,700. Whether this is derived from the shaft H. P. measurement or confirmed by the shaft H. P. measurement we do not as yet know. But if this figure—5,700 I. H. P.—sent to us is correct, the coal works out at 1.56 pounds per I. H. P., including all auxiliaries. The coal result is, if anything, better than these figures show, for during two hours the safety valves were blowing and the steam by-passing to the condensers. On a basis of the cube of the speeds the H. P. at 20 knots would be 8 per cent. greater than that at 19½ knots, and as the coal consumed at 20 knots was only .864 per cent. of that guaranteed for 19 knots, it would appear that at a speed of 19 knots the coal consumption would be just 80 per cent. of the amount guaranteed.

The dimensions of the vessel are as follows:—

Water line, 310 feet.

Beam, 38.2 feet.

Draught on trial trip, 9.74 feet.

Displacement, 1,890 tons of 2,240 pounds.

In order to test the manœuvering and backing qualities of the turbines, which were entirely independent, another engine driven vessel belonging to the same line (the Hamburg Line) was brought to the spot for comparison, and it was found that the turbine ship was brought to a stop in the water in slightly less time than that occupied by the engine driven ship. I am informed that during the trials the turbines gave no trouble and their practical operation was entirely satisfactory.

Each turbine is built in the form of a drum-shaped shell built in sections, the shell having a length of about 11½ feet and an outside diameter of a little over 8½ feet, the reversing apparatus being all contained within the same shell. The weight allowed for each turbine was 70 tons and the actual weight was 57 tons.

A very remarkable feature of the result seems to be the screw performance at tha unusually high revolutions. Three or four pairs of screws were tried before the desired result was obtained, the turbines originally having been intended to run at 600 revolutions. The characteristics of the screw we have not as yet ascertained and cannot, therefore, state them, but it would seem from the excellent performance of the propelling machinery as a whole that the screws must have been surprisingly efficient in their action, considering the fineness of pitch involved.

Shop tests of the turbine to ascertain their H. P. economy had previously been conducted, the power developed being measured by a disk water brake with the following results:

With a boiler pressure of 12 atmospheres or 190 pounds abs. with dry steam and a vacuum of 28 inches the steam consumption per brake H. P. was 12.76 pounds at 600 revolutions and about 13.42 pounds at 500 revolutions.

The application of this type of turbine for driving electric generators has received an extensive development by the General Electric Company under the very able and energetic direction of Mr. W. L. R. Emmet, who early foresaw its advantages and who has introduced many new mechanical features in design and construction. One novel feature introduced by Mr. Emmet was the vertical shaft form. In this form the entire weight of the rotating parts, comprising the turbine wheels and the revolving field or rotor of the generator, and amounting in the larger sizes to something like 75 or 100 tons, is mounted on an oil or water step bearing, which really is not a bearing at all, but a fluid cushion support under pressure sufficient to carry the entire weight, without permitting metallic contact. The success of this bearing in the face of the criticisms and predictions often made, has been quite remarkable. The total number of turbine units thus far shipped by the General Electric Company is about 290 and those on order about 200 more. These units vary in capacity from 15 k. w. to 8,000 k. w., more than 60% of them ranging from 500 to 8,000 k. w.

It is reported that Clarence Gray Dinsmore, shortly before his death, gave a sum of $2,000 to the Herkomer contest committee of the German A. C. for a cash prize to be awarded in connection with the Herkomer touring contest.

European engineers, in choosing pipe lengths, are not handicapped as engineers in the United States are. Pipes 20 ft. in length are the longest size usually found in this country, but in Europe pipe may be obtained up to about 50 ft. in length without special difficulty.

The subject of the education of apprentices was considered at a recent meeting of the Cincinnati Metal Trades Association, and the proposed coöperation between the shop owners of Cincinnati and the University of Cincinnati was referred to by Mr. Will Geier and Prof. Herman Schneider of the University.

AMERICAN MACHINIST

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Professor Sweet's Artisan School.

Friends of Professor Sweet know that for some time past he has been hoping to establish in his home town of Syracuse, N. Y., a school in which boys may be taught the trades concerned in machine construction, and in which school they will have a better chance to acquire real knowledge of the business than is possible in most machine shops. The many who read this journal and who are familiar with his ideas upon the subject will be glad to know that such a school will be established, and in reply to inquiries about it, Professor Sweet is sending out a circular letter from which we quote as follows:

"Our first building is to be a machine and pattern shop, and a room for drawing, writing, class room or lecture room and lavatory. We hope to be able in this building to accommodate 25 or 30 boys, who are to be given the best opportunity to learn the machinists' or pattern-makers' trade that we can give them, with instruction in practical drawing, in such mathematics as they will need in their trade, and in descriptive writing.

"The shop work is to be from 8 to 12 o'clock, and from 1 to 4; from 4 to 6 will be devoted to whatever seems best for each individual student in the school room. The entrance deposit, which is simply to insure good faith, is $36.00, which amounts to $1.00 per month for three years; there is to be no tuition. Each student is to have four weeks out of each year, as may be arranged. If the student is compelled to leave before the end of three years because of illness or other cause beyond his control, he is to receive back the proper proportion of his deposit; but if he is dismissed for misbehavior, he forfeits his deposit.

"The only special requirements for admission are, the applicant must be able to read and write, must want to learn to make something, and show an inclination to want to do something, and must show a disposition toward good conduct.

"It will be our aim to make accomplished workmen, to create in the students a spirit of pride in their work, and pride in the fact that they have been workmen in the Artisan School. At the completion of the three years' course, we will find them employment, or if before the three years we can, we hope, recommend them as accomplished workmen, and they wish to take some position, we will allow them to do so. The incentive to work will be this: when they are able to do any certain class of work well and rapidly, they will at once be given better work. If this makes good machinists of them in two years, as we hope will be the case in some instances, then they can take up tool making. If they show a special aptitude at drawing, and want to follow that calling, they will be given all possible assistance in that direction; or if they show engineering ability, can afford it, and are qualified, we will release them at any time and secure credit for shop work for them in some mechanical engineering college.

"It is the aim of the school, after two or three years, if possible to do so, to make it self-supporting; if more can be done, it will go into betterments. If it can be made self-supporting, then the students can go away feeling that they have not been objects of charity, and with a trade that will be worth to them more than many thousands in money. We hope to make a name for the Artisan School that will be a passport into any shop in the country."

Professor Sweet asks us to add what he forgot to say, i.e., that Saturday afternoon will be a holiday.

The ability to think about work is of far greater importance than anything else to the learner in the machine business, and in this school thinking will undoubtedly be greatly stimulated and the boy who, having a taste for things mechanical, and whose parents can pay the entrance fee and expenses of the boy during the course, will be fortunate indeed to gain admittance there.

The officers of the school are Alexander T. Brown, president; F. R. Hazard, vice-president; John R. Montague, treasurer; S. D. W. Cleveland, secretary; John E. Sweet, superintendent.

Of these, besides Professor Sweet, we know only Mr. Brown, who is the well known inventor and manufacturer of Syracuse; but all of them, by subscribing to the funds, and devoting time to the work, have shown that they can be interested in things designed primarily to help others. We are sure all our readers will join us in the hope that Professor Sweet's school will grow to be the crowning achievement of his life, and that it will endure for long after he himself shall have ceased his activities.

The Water Meter.

Citizens of Philadelphia and of other places, who may have opposed the introduction of water meters on service pipes would do well to see and study the report of James H. Fuertes, M. Am. Soc. C. E., who was selected by a committee of the Merchants' Association of New York, of which Henry R. Towne is chairman, to investigate certain questions connected with the general problem of New York's water supply.

Mr. Fuertes examined into the experience of a large number of cities—foreign as well as American—with water meters; the result being the most complete endorsement of the meter and a demonstration of its great usefulness in preventing needless waste of water, while at the same time reducing the cost to water users. Summing up his review of the experience of American and German cities Mr. Fuertes says:

"(1) Wastage and leakage can be quickly stopped and permanently suppressed without depriving any citizen of the use of as much water as that to which he has been accustomed. That the question of the suppression of the greater part of the wastage is to all intents and purposes merely a hunt for leaks followed by the watching of the different consumers and the insisting that they keep fixtures from leaking.

"(2) That sale of water by measure has no tendency to restrict the use of water, but does notify the owner when the leakage from the faucets and other fixtures is serious enough to require attention. That wastage from domestic premises is rare, but that leakage is prevalent. That tenants do not wilfully waste water, and that the blame for the present conditions in New York rests not upon the hundreds of thousands of users of water, but upon the relatively few owners who neglect to keep their plumbing in order as required by the city ordinances. That the responsibility for this state of affairs rests primarily with the system under which the water is sold. That the sale of water by meter does not work a hardship on owners of property rented to tenants; in practically all cities, from Berlin to Asbury Park, the water taxes are liens on the property, and yet, in no city, where the system has been adopted permanently, and where the rates have been properly adjusted, would either the water-works managers or the inhabitants of the city go back to the old system."

This report is perhaps the most important and convincing thing that has ever appeared upon the subject. We hope some means will be found for placing it in the hands of every city engineer and water board, to the end that people who use water in cities may get what they pay for, and pay for what they get, and that water-meter manufacturers may no longer be cheated out of business that legitimately belongs to them, and which by every commercial and economic law they have earned the right to do.

The Sageness of Sage.

Much is being said about the career of the late Russell Sage now that he is dead and gone, but precious little can be found to say about him, except that he was a wonderful money accumulator and hoarder; otherwise he was simply a negatively good man, i.e. he had no bad habits, but on the other hand he had no particularly good ones. He devoted his entire time and talents to the gathering of money and holding on to it, and having no children, practically the only thing he could do with his $150,000,000 when he died was to leave it to be administered by his more charitably inclined and more broad-minded widow. Even the few things he is credited with are likely, it seems, to be disputed. A Wall street publication speaks of his efficiency as a director of corporations and quotes a fellow director as saying that "no man made a better trustee of other people's money," whereupon our contemporary, the *Electrical World* expresses a different view as follows: "We are a little inclined to join issue here. It is no crime in our eyes that Sage was an intimate friend of Jay Gould, or was always eager for his director's fee, but we have ever held it against him that long after electric traction had demonstrated its ability to increase enormously the productiveness of a transportation property, he opposed tooth and nail its use on the Manhattan system. He saw the road losing business and its traffic melting like ice in the sun, but still he wanted no such costly change as that, if only the old dividend could be squeezed out. Now a directorship held in that fashion is pernicious and unfaithful to the last degree, involving the destruction and not the preservation of the property trusteed. In like manner it has always been understood that the parsimony often seen in the old Western Union management, so hurtful to telegraphy, was due more to Sage than anybody else. The directors' board is better without such men, for they stand in the way of justice to employees and are enemies of public progress."

The true conservative who simply insists upon satisfactory evidence of the wisdom of a proposed expenditure has his uses of course; but a man who simply possesses a talent for holding onto money until compelled to let go of it has no use so far as we can see.

By the way, our contemporary whom we have quoted opposes "tooth and nail" the municipal ownership of public utilities, and to judge from some things we have seen in its columns it should, to be entirely fair, charge the old time backwardness and old fogyism of the elevated railroad management to the fact that it was privately owned—owned by men who (very properly we think) regarded it as their property—held for the purpose of making money for its owners. The harm done by such men as Sage in blocking the wheels of progress and by others owning public franchises in corrupting and debasing municipal, state and national legislative bodies seems to escape the notice of our contemporary entirely when dealing with the question of public ownership of public utilities and it seems able to see only balances made by accountants and designed to show whether or not publicly or privately owned utilities are the more economically managed.

The United States Trade Reports Fraud.

The gentry who manage the *United States Trade Reports* of Cincinnati, Ohio, sought to victimize the Three Rivers Tool Company, of Three Rivers, Michigan, by offering to publish in their delectable journal an alleged description and puff of the reamers made by the company mentioned. The Three Rivers Company, was, however, too wise to be caught by the game, and sends us the correspondence, together with a sample copy of the *United States Trade Reports*, which is the first we have seen for some time. It is a very interesting journal, and we note that it is not entered in the Cincinnati postoffice as second-class matter, which of course it would be if it had subscribers and could conform to the postal regulations required of genuine publications. This number contains, among other things, an interesting puff of a certain beer brewed in an obscure town in Pennsylvania; an article about certain special hand presses, made by a builder in New York City; an article on "Absolutely Pure Catsups," as made by a certain manufacturer in Ohio; an article entitled "Perfect Violins," which it is claimed are made by a certain man in Chicago; an article about an equalizing weight for automobiles; an article on the best banking and trust company; and another on the best "hickory fiber for street-sweeping machines." All these things purport to have been carefully examined by a staff of experts employed by the *United States Trade Reports*, and all of it is of course pure and unadulterated humbug and fraud. Those who are somewhat acquainted with the exigencies of making-up time in a newspaper office will readily recognize also that our alleged authority finds it convenient to have on hand a number of electrotypes pertaining to almost any old thing, and which are simply thrown in when other matter to fill the paper is lacking. Some of these have been put into the number before us, but there is no reference to them, or explanation of why they are inserted, or what it is that might be said about them. The journal bears every mark of being what it is, a fake and fraud, and we don't suppose any manufacturer who really examines the sheet is ever caught by the game. It is an impudent and palpable swindle.

The annual picnic given by the Lunkenheimer Company, of Cincinnati, to its employees took place this year on the 28th of July. The employees, with their families to a number sufficient to fill two trains of ten cars each, went to Woodsdale island about 30 miles from Cincinnati, where there were various amusements, music, etc., all of which were highly appreciated.

The Builders' Iron Foundry, Providence, R. I., announce that the works will be closed from August 24 to September 4, for the annual vacation and repairs. The office will be open as usual for business, but it is recommended that wants be anticipated so far as possible.

New Tools and Machine Shop Appliances.

EIGHT-SPINDLE REAMER CENTERS.

In general work the usual method of cutting teeth on an irregular cutter or reamer is to cut the teeth on the different sections separately, but in the machine shown the cutter follows the outline automatically.

The work shown in Fig. 1 is a bridge reamer, having a straight body and a taper end. Eight reamers are handled at one time and are indexed simultaneously. The tailstock is adjustable, each spindle has an independent forward movement by spring and a separate handle to throw it back.

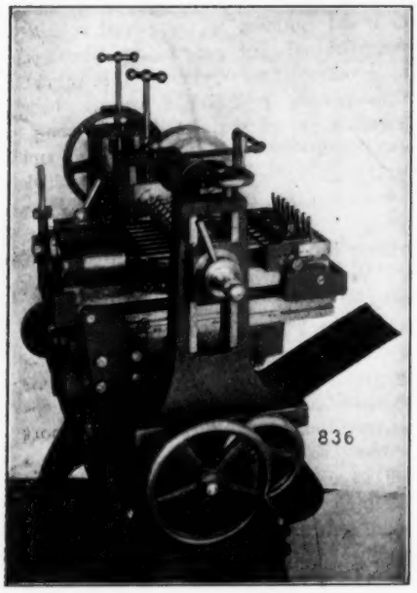

FIG. 1. EIGHT-SPINDLE REAMER CENTERS.

The whole eight spindles are bound by two screws *A* (see Fig. 2), one on each side of the tail block. This is accomplished by using a binder plug *B*, similar to a turret-tool binder, between each pair of spindles. The two binders for each group of four spindles rest on two wedges *C*, which are forced apart by right and left-hand screws with freedom to equalize between the two plugs.

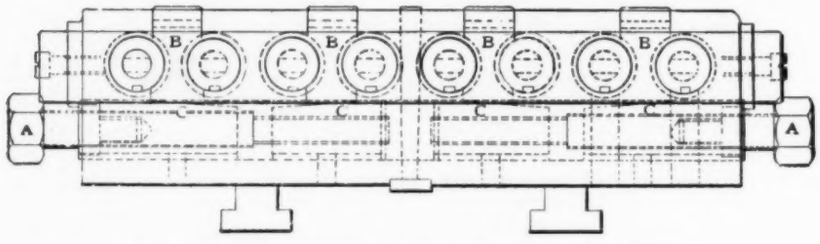

FIG. 2. SHOWING BINDING MECHANISM FOR THE SPINDLES.

The work has a Morse taper tang, which fits a slot in the end of each headstock spindle; a small center supports it and the slot drives it around.

The headstock and tailstock are mounted on a tilting table, carried on the regular table of the machine. It is pivoted at the tailstock end and provided with a steady guide at the head end.

To the saddle of the machine are attached two brackets, one on each side, carrying rollers; and on each side of the tilting table is secured a steel former, which rests on one of the fixed rollers.

The power feed to the main table being thrown in, the formers are pushed along over the fixed rollers and force the tilting table to rise and fall to accommodate the profile of the work.

The weight of the slide and the pressure of the cut and feed keep the table down and prevent chatter. It is obvious that this principle is applicable to many other kinds of work besides reamers, such as milling breech blocks of guns, or other irregular pieces having a rounded edge precluding form milling, and affording a simpler design than that of a swinging-cutter spindle.

The machine weighs 2250 pounds and has a capacity of 120 reamers a day. The centers take up to 1⅜ inches diameter, by 14 inches long. The makers are the Garvin Machine Company, New York.

The Link-Belt Company.

We noted last week, briefly, the fact of the organization of the Link-Belt Company. We have received the following further statement of facts regarding this consolidation:

The Link-Belt Machinery Company, of Chicago, the Link-Belt Engineering Company, of Philadelphia, and the Ewart Manufacturing Company, of Indianapolis, are now consolidated, the name of the new firm being, Link-Belt Company. The Philadelphia and Indianapolis plants have been purchased by the Link-Belt Machinery Company, and will be operated as heretofore, in conjunction with the Chicago plant.

The Chicago and Philadelphia firms have been building conveying machinery on what is practically identical lines, but the Indianapolis plant has confined its operations to the manufacture of chains, one of its standard products being the original "Ewart" detachable link-belting, now so universally known.

The organization of the first Link-Belt Company was effected in 1880 by the establishment, in Chicago, of the Link-Belt Machinery Company. New York was made the Eastern headquarters in 1882, and in 1888 a new firm, the Link-Belt Engineering Company, was organized and located in Philadelphia, succeeding the firm of Burr & Dodge, the New York office passing into its control.

The officers of the new company are: James M. Dodge, Philadelphia, chairman of the board; Charles Piez, Philadelphia, president; Glen G. Howe, Indianapolis, 1st vice-president; Staunton B. Peck, Chicago, 2d vice-president; S. Howard-Smith, Philadelphia, treasurer; P. G. Reid, Philadelphia, assistant treasurer; Dyke Williams, Chicago, secretary; Edward H. Burr, Philadelphia, assistant secretary.

Personal.

Frank E. Greene, who for the past six years has been general foreman of one of the machine departments at the Westinghouse Machine Company, East Pittsburg, Penn., has resigned to take a position with the Fairbanks-Morse Manufacturing Company, Beloit, Wis. His friends in Pittsburg presented him with a diamond pin.

E. R. Douglas has resigned his position as specifying engineer with the Crocker-Wheeler Company, Ampere, N. J., to accept that of mechanical superintendent with Adriance, Platt & Company, Poughkeepsie, N. Y. Mr. Douglas has been connected with the Crocker-Wheeler Company for the past nine years. He will enter on his new duties September 1.

Business Items.

The Parsons & Lane Company is the successor to Parsons & Lane, of Sodus, N. Y., and will continue to operate the plant, which is well equipped for general machine work. The company will build special machinery, specializing in thread milling, in which line it will cut blanks furnished to it, or it will furnish parts complete for all worms and coarse-pitch screws, either standard or special threads. W. T. Gaylord is president, B. B. Kelly, vice-president; H. L. Kelly, secretary; A. H. Lane, treasurer; and W. N. Parsons, general manager.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Working drawings, experimental work. George M. Mayer, M. E., 1131 Monadnock Block, Chicago, Ill.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine

shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

Wanted—Back numbers of AMERICAN MACHINIST and MACHINERY, from January, 1900, to December, 1905. State price. T. J. VW., Suite 412, Arbuckle Building, Brooklyn, N. Y.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

The University of Cincinnati has a few positions to offer energetic young men who desire to take an engineering course while supporting themselves in large measure by working as apprentices in the machine plants of Cincinnati. For information apply to Secretary, University of Cincinnati, Cincinnati, O.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Wanted—Agents in every State to handle exclusive territory on the Cone Gas Generator, which generates coal gas for stationary engines from 25 h.p. up, reducing the cost to 1/5 that of steam power; agents must be conversant with machinery business and devote entire time to the work. Cone Gas Machine Company, 1036 Majestic Bldg., Detroit, Mich.

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Going machine shop, situated in northern Ohio; natural gas; will bear strict investigation; good reason for selling. Address Box 525, Tiffin, Ohio.

For Sale—One 50-h.p. gasolene engine, used only a few months and good as new; also one 25 h.p. Address Detroit Engineering Works, Chene and Guoin streets, Detroit, Mich.

For Sale—One plain tank, 5'6"x9'8"; one Hazelton heated, 4'x23'4"; one expansion tank, 5'9"x23'5"; one Berryman heater, 4'x 20'. Studebaker Bros. Mfg. Co., South Bend, Indiana.

Business Opportunities.

Boat-manufacturing business, nets $7700 annually, besides salaries, wants active partner; must invest; are enlarging; business 30 years old. Box 914, AMERICAN MACHINIST.

Wanted—Capital to start manufacturing patented cutter and reamer. This is a money and labor-saving tool, something which will sell on sight. Would consider proposition of a firm desiring to add a new line of manufacturing. Address Box 926, AMER. MACHINIST.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Wanted—Position as shop superintendent or general foreman; experience 14 years on light and heavy machinery, tools for cutting and forming sheet metal or wire; will be open for position Sept. 1. Box 886, AM. M.

ILLINOIS.

Mechanical engineer—technical graduate, with 10 years of manufacturing and business experience, wide and influential acquaintance —would like Chicago position, superintendent, manager branch agent. Box 924, AM. MACH.

MARYLAND.

Position as superintendent; experienced in pattern, foundry and machine shop; good executive and organizer; well up in labor-saving appliances and modern manufacturing; can produce results; now holding position of responsibility; good reason for seeking change; references. Box 883, AMERICAN MACHINIST.

MASSACHUSETTS.

Toolmaker—Fifteen years' experience jig and fixtures on gun and typewriter work, punch and dies, model making; references. Box 902, AMERICAN MACHINIST.

Wanted—Position where inventive mechanical ability is required. I am 34, single, technical graduate, with 14 years' shop and drafting experience. Box 928, AMER. MACHINIST.

MISSOURI.

First-class toolmaker desires position outside of shop. Box 917, AMERICAN MACHINIST.

NEW JERSEY.

Foreman—33, of good address, with varied experience designing and building of special machinery—desires to make a change, within commuting distance of Montclair, N. J.; salary $1800. Box 905, AMER. MACHINIST.

Machine, pattern-shop foreman—36, American, experienced in handling help and keeping costs down—desires change to larger plant; now employed; can "push" help; will locate anywhere; best references. Box 918, AM. M.

NEW YORK.

Superintendent or assistant, with practical mechanical experience; best references; age 42. Box 923, AMERICAN MACHINIST.

Experienced superintendent and buyer, several years with present firm; light or medium work; rapid production, with interchangeability, cost, stock and tool systems. Box 896, AMERICAN MACHINIST.

Salesman, practical mechanic, with 12 years' selling experience here and abroad, open for position, or to represent manufacturer in New York, salary and commission. Box 921, AMERICAN MACHINIST.

OHIO.

Mechanical engineer — German-American, good salesman, with large experience and thorough technical training, having extensive acquaintance among manufacturers and business men in Germany and England—wishes to represent American house, with residence in Germany. Apply Box 873, AMER. MACHINIST.

PENNSYLVANIA.

Mechanical engineer, general mill work, would accept position as chief draftsman or assistant superintendent. Box 884, AM. M.

Mechanical engineer, with large experience, wants position as chief draftsman, superintendent, master mechanic or as mechanical salesman; experience on rolling mill, blast furnaces, engine work, special machinery, etc.; charge of work for many years. Box 882, AMERICAN MACHINIST.

WISCONSIN.

Expert designer, with extensive experience on machine tools, special automatic machines and modern equipment, and familiar with latest and best methods of handling manufacturing problems. Box 922, AMERICAN MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Wanted—A first-class blacksmith on heavy machine forging. Address, stating experience and salary required, Farrel Foundry and Machine Co., Ansonia, Conn.

Wanted — High-grade floor and machine hands; steady work and good wages to first-class men familiar with heavy work; none other need apply. Address, stating experience and wages required, Farrel Foundry and Machine Co., Ansonia, Conn.

ILLINOIS.

Wanted—Foreman for shaft-grinding department in factory at Chicago, Ill.; department equipped with Brown & Sharpe and Landis grinders; steady position for capable man. Address Box 904, AMERICAN MACHINIST.

Wanted—Detail draftsman on high-grade moderately heavy work; prefer Swedish technical graduate; state experience, married or singe, and pay expected; steady place for good man. Box 908, AMERICAN MACHINIST.

Wanted—An experienced factory superintendent for the manufacture of a variety of metal specialties; man must be of good character, reliable, painstaking, mentally alert, and a thorough master of detail. The factory is new and well equipped. Salary $2000 per year, but superintendent must make cash investment of $3000 and contract for three years. Box 871, AMERICAN MACHINIST.

INDIANA.

Wanted, at once—A capable and experienced diesinker for automobile work. Box 907, AMERICAN MACHINIST.

LOUISIANA.

Wanted—Two first-class machinists accustomed to general jobbing work; good wages and a steady job to the right parties. Address F. H. Koretke Brass and Mfg. Co., Ltd., New Orleans, La.

MARYLAND.

Wanted—A man to act as master mechanic and to superintend the designing of all tools and fixtures for the interchangeable and economical manufacture of large quantities of automobiles; steady position to right man with one of the largest automobile manufacturers. Box 909, AMERICAN MACHINIST.

MASSACHUSETTS.

Skilled man accustomed to spiral gear cutting; must have ability and good references. Boston Gear Works, Norfolk Downs, Mass.

Good mechanical draftsman — State age, education, experience and initial salary expected. Address General Electric Co., West Lynn, Mass.

Wanted in New England, competent draftsman and designer for concrete construction; must be posted on latest methods; state age, experience and salary expected. Address Box 829, AMERICAN MACHINIST.

A practical machinist, capable of handling fine and accurate work, or, if necessary, getting out the ordinary class of work in money-making time. There is a field in special machinery and the advertiser has shop with established business along this line, which can be increased with profit. To the right man with large experience an interest with charge of the shop is offered. Investment of about $5000 would be advantageous. I am not looking so much for the capital as the man. In answering, state what your experience has been, to insure answer. Address Box 894, AM. M.

MICHIGAN.

Machinists wanted—A first-class layer-out and several first-class floor hands on electric traveling-crane work. Northern Engineering Works, Detroit, Mich.

Wanted — Experienced mechanical draftsman by a large concern building railway supplies; must be able to do detail designing in a practical manner; man familiar with both structural steel and light car work preferred; permanent employment to right party; references required. Address Car Builder, Box 912, AMERICAN MACHINIST.

Wanted—Our annual vacation comes between the dates of Aug. 11 and 27; immediately after this time we will need a number of first-class toolmakers. We want only men who have had experience on accurate tools, jigs and fixtures for interchangeable machinery, and to such we can offer steady work at good wages. Box 911, AMERICAN MACHINIST.

MINNESOTA.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

MISSOURI.

Instrument assemblers wanted—Four experienced instrument assemblers; permanent to good men. Apply in writing, stating experience and wages desired. Wagner Electric Mfg. Co., St. Louis, Mo.

Wanted—Designing draftsman, one who has had a wide range of experience on large gas engines and producer plants; in writing, give full details as to previous and present records, salary expected, also when position can be accepted. Address Box 910, AMER. MACHINIST.

NEW HAMPSHIRE.

Wanted—A thoroughly reliable and hustling master mechanic or shop foreman who can handle 100 or more good American workmen to best advantage and get out a good production; must be competent designer of tools and jigs for making in duplicate medium automatic machinery accurately and cheaply; conversant with up-to-date machine-shop methods and organization. Address, giving experience, references and salary expected, Box 878, AMERICAN MACHINIST.

NEW JERSEY.

Mechanical draftsman wanted on electrical work, at once. Apply at Edison Phonograph Works, West Orange, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe

hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Wanted—Foreman diemaker to operate a small automatic hardware plant Box 920, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Draftsmen on jigs, fixtures and tools wanted; experienced men only. Mergenthaler Linotype Co., 20-42 Ryerson street, Brooklyn, N. Y.

Wanted—Draftsman experienced in designing machinery. Address, with particulars, Niagara Machine and Tool Works, Jefferson and Superior streets, Buffalo, N. Y.

Toolmakers wanted — Experienced men on punches and dies and general tool work. Steady positions for the right men. Remington Standard Typewriter Factory, Ilion, N. Y.

Wanted—By a large manufacturing concern, several detail draftsmen and tracers on machine and tool work. Write, giving age and experience, F. G. H., Box 916, AMER. MACH.

Draftsmen wanted on details of light wood and steel construction work; accuracy in dimensions essential; good jobs for good men; state age, experience and salary expected. Address Box 899, AMERICAN MACHINIST.

Wanted—Three first-class lathe hands for gasolene-engine crank shafts; steady work and good pay to right men; write or apply at works. Gas Engine & Power Co. and Chas. L. Seabury & Co., Consolidated, Morris Heights, New York City.

Wanted — A-1 mechanic and instrument maker, experienced in the manufacture of fine instruments; one capable of taking charge of a department preferred; liberal wages to right man. Answer, stating experience, Box 928, AMERICAN MACHINIST.

Wanted — Foundry foreman for gray-iron foundry in central part of New York State employing about 50 men and making a great variety of work; must be a man of fair education, good executive ability and up to date in modern foundry practice; salary $2000. Address G. I., Box 906, AMERICAN MACH.

OHIO.

Wanted—By the Bickford Drill and Tool Company, Cincinnati, O., experienced toolmakers, vise and scraper hands.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Wanted—Young man who has made a study of and has had experience in gas-engine designing. Address, "Motor Car," Box 929, AMERICAN MACHINIST.

Wanted — Competent toolmakers familiar with fine work on small punches, dies and small jig work; permanent position with good pay under best of conditions. Box 925, AMERICAN MACHINIST.

Chief mechanical draftsman, technical graduate, experienced transmission machinery; good permanent prospects with growing concern in Ohio; state definite qualifications and salary expected. Box 802, AMER. MACH.

Wanted—A thoroughly up-to-date machinist, one who understands his business and can handle men as foreman; prefer a man with from $1000 to $3000 to take stock in the company; position open Sept. 1. Address Box 903, AMERICAN MACHINIST.

Wanted—Three first-class draftsmen familiar with the design and construction of electric traveling cranes; also one structural draftsman; permanent position and good wages guaranteed; only experienced men need apply. Address Case Mfg. Co., Columbus, O.

PENNSYLVANIA.

Wanted—First-class machinists and toolmakers; good wages to right parties; no labor troubles. Box 857, AMERICAN MACHINIST.

Wanted — Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Foreman with experience in shop manufacturing electrical goods; in writing, state experience and salary expected. Box 913, AMERICAN MACHINIST.

Wanted—Draftsman with shop and drawing-room experience, one with paper-machine experience preferred; state qualifications, age and salary expected. Box 915, AMER. MACH.

Wanted—A working foreman tinsmith, one who has had experience in the automobile line, who could make hoods, dashes, radiators and other necessities to the automobile in the tinsmith line; one who has held a similar position preferred; must be a hustler and able to earn the highest wages; in answering, state where now employed, giving references, age and experience. Box 892, AMERICAN MACHINIST.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

Draftsman and designer in a shop employing about 50 hands and manufacturing light machine tools, hydraulic and pneumatic appliances. We want a capable man, self-reliant, accustomed and able to take an idea and reduce it to practical form, with the brains and disposition to stick to a problem until it is solved. If you do not have these qualifications, don't write. A pleasant position and chance of advancement to the right party. Location, Philadelphia. All communications will be treated confidentially. Give full particulars as to past experience, age, present employment, and state salary expected. Box 859, AMERICAN MACHINIST.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

VIRGINIA.

Wanted, at once, diesinkers; steady work at 50 cents per hour; also several good trimmer makers. Address P. O. Box 686, Richmond, Va.

WEST VIRGINIA.

Wanted—Foreman for machine shop employing about 15 men on general work; must be energetic and familiar with modern shop practice; state age, experience and salary expected. Location on the Ohio river, about 50 miles south of Pittsburg. Address Box 872, AMERICAN MACHINIST.

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., Milwaukee, needs more patternmakers, machinists and moulders.

Machinist to construct special iron-working tools; good wages and steady work to the right man. Address Thomas B. Jeffery & Company, Kenosha, Wis. (Rambler automobiles). Kenosha is 52 miles north of Chicago.

Wanted—A few first-class machinists, toolmakers and patternmakers; shop one of the best in the country and equipped throughout with the highest grade of tools; city one of the best in the country; educational facilities of the best; pure water, etc.; only steady, reliable men looking for permanent positions need apply. Address Box 848, AMER. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., is constantly increasing its works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

Foreman—Mechanic for steady employment to act as foreman of an automobile repair department at our factory; ability to rapidly comprehend and to conscientiously carry out instructions more desirable than special knowledge of automobiles; wages depending on ability, but we would prefer one that is worth $30 weekly to one of less earning capacity. Box 825, AMERICAN MACHINIST.

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An English Special Rod-Grinding Machine.

BY I. W. CHUBB.

The firm of Hans Renold, Ltd., Manchester, England, necessarily employs in the production of its various chains a number of special appliances of an interesting character. Among the tools designed by the firm for its own use, is a line of grinding machines to deal with straight circular rods up to say 0.8 inch diameter. Some of these machines have been in operation for a considerable period, and it is the latest and largest machine which is specially referred to here. The principles of construction and operation remain the same, however, the differences being found in size and in such small details as are usually in an earlier machine, found from experience capable of some slight improvement. Thus the arrangements for catching the water and preventing spray falling on the wheel are points in which improvement has been made. The machine here illustrated in front view from opposite ends by Figs. 1 and 2 will grind mild-steel rods from 0.325 to say 0.8 inch diameter of any length and guaranteed to size within 0.0002 inch. This is the positive limit, that is the rods may be full by that amount, but they must never be below the nominal size. A roughing and finishing cut can be taken over each rod, and as to output, 7-foot lengths of mild steel of 0.325 inch diameter can be finished at the rate of 50 to 60 per hour, while similar lengths, say 0.5 to 0.75 inch diameter, are completed at the rate of 35 to 45 an hour. The rods are put through in batches, first for roughing and then for finishing, and the output figures here given cover the two operations.

Before being ground, the bars are passed through a straightening machine and in addition have their ends pointed slightly to take off the bur and permit them to enter easily. This straightening process is essential to success. The rods are then taken to the grinding machine, a pile of stock being placed on the supporting arms and passed one by one into the channel iron from which they enter the machine. Similar arrangements are made at the outgoing end. They are fed into the machine by a pair of rotating disks at the left hand. They then pass through guides, across the face of the emery wheel, are then wiped mechanically, drawn through by another pair of rotating disks at the right-hand end of the machine, oiled and removed. The feeding action is continuous and bars of any length can be treated. It will be seen that excepting as regards cross feed, the emery wheel has a movement of rotation only. It is about 16 inches diameter by 2 inches wide with a 5-inch hole. A compound wheel is used, half the face being suitable for roughing and the other half for finishing. The overhead motion has a four-step cone pulley provided so that the wheel, from 12 to 16 inches diameter, can be arranged to run at a cutting speed of from 5000 to 6000 feet a minute.

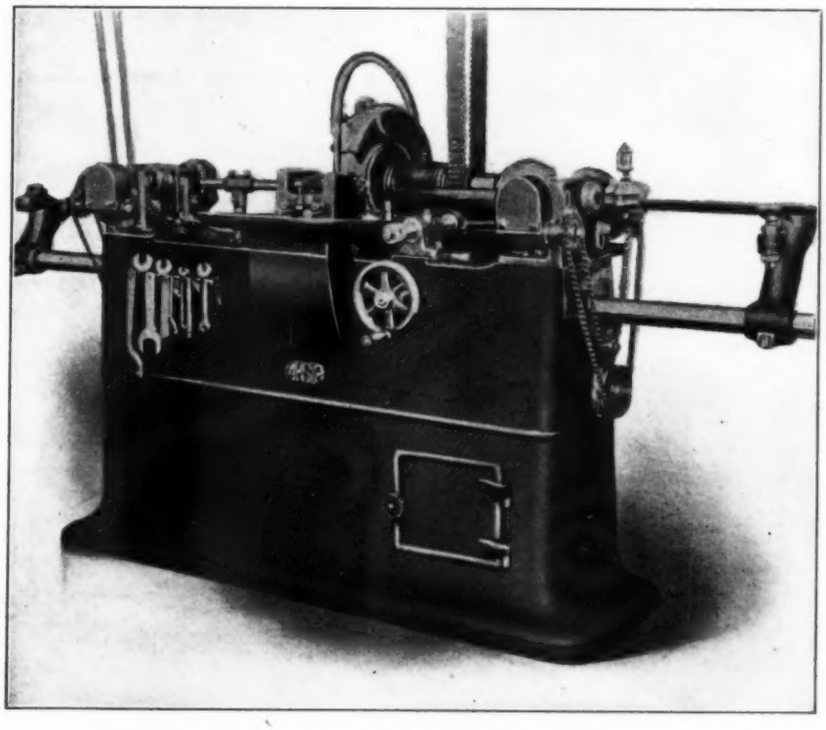


FIG. 1. ENGLISH SPECIAL ROD-GRINDING MACHINE.

These wheels are mounted in the ordinary way and the spindle has a bearing 2½ inches diameter by 7 inches long at the front and 1½ inches diameter by 6 inches long at the back. The thrust is taken entirely at one end, leaving the other bearing free from movement of expansion due to any heating which might possibly occur. Like the whole machine, the slide carrying the wheel spindle is exceedingly massive, with the object of absorbing vibration. The slide has wide gibbed bearing surfaces and is guided in a narrow long central way to insure correct and smooth travel to and from the work. Thus by means of a cross screw having a hand-wheel in front of the machine as shown, the wheel and spindle can be traversed to and from the work and be moved across the bed to the rear for adjustment and replacement of wheels, a nut for the cross screw being fitted in a projection on the slide. The final position is controlled by means of an adjustable micrometer and stop as illustrated in Fig. 3. The wheel is covered, the wheel-guard itself sliding in a guide way. The base is heavy and stands on a three-point bearing. Advantage has been taken in the design, to allow the water to fall from the wheel on a smooth curved surface which thus prevents splashing and spraying. The tank into which the water falls is divided into three compartments, the first of which, by means of an easily removed settling pan, extracts the major part of the grindings. In fact it is found that all solid matter is practically removed in the three strainers and that finally clean soda water is passed through the pump. This is of the well known Brown & Sharpe pattern and is belt driven.

The rod under treatment is not only fed across the emery wheel by the disks at the ends, but is also rotated by them. These disks run on horizontal axes, which are, however, slightly inclined to one another so that the rod is gripped on entering and passes toward the emery wheel freely. The rod is, of course, held between opposing faces of the disks. These must be adjusted for the diameter of the rod and are set up by guide pieces, one for each size of rod. Each guide consists essentially of a bush through which the rod passes and on which two flats are machined; to these flats the disks are set. The real driving faces are narrow rings of hardened steel and are easily replaced when worn. They are inclined on the face to suit the amount by which the disks are offset. Obviously if the axes of the bar and the disks are in one plane, the bar will receive a movement of rotation only. If, however, one disk is raised and the other lowered relatively to the rod, the movement will be rotation combined with translation or longitudinal movement, some slip being inevitable. The feed can therefore be adjustable by altering the hight of the disks relative to the rod. So that the adjustment may be equal

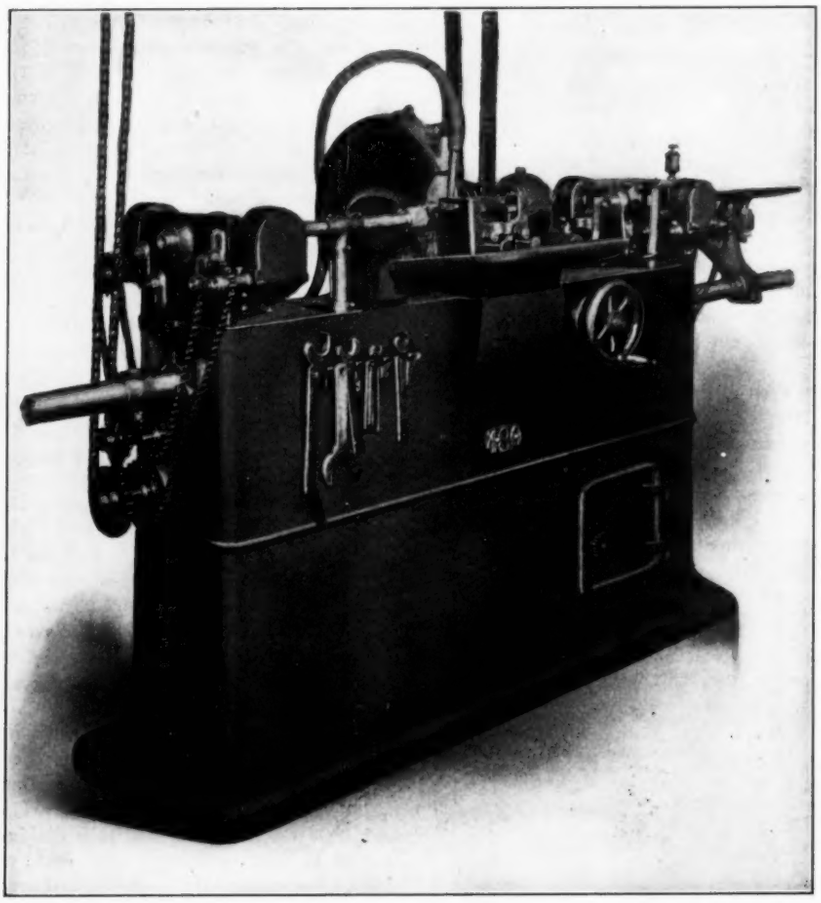


FIG. 2. ENGLISH SPECIAL ROD-GRINDING MACHINE.

and easy, graduated scales are fitted. The arrangements for feeding and for withdrawing the rods are the same; for, as has been stated, a pair of disks is used at each end. Both sets of disks run at the same speed, no allowance being necessary for the difference in diameter between the ground and rough rod. If, however, a considerable amount is to come off, as say 0.007 inch, the practice is to take off say 0.006 at one cut, leaving 0.001 for finishing. Each disk is driven by a spiral gear at each side, the angle of the tooth making up for the angular set of the axes, while the spiral gear allows for the lateral displacement. This gear runs in a bath of oil and, like the emery-wheel spindle, is driven by a chain, to be described later. From the first pair of disks the rod passes through a pair of steady guides, each consisting essentially of a tapered bush, and then across the face of the wheel to a similar guide, and again to the second pair of disks. The back rest for the wheel is rectangular, having a semi-circular groove to suit the size of the work, and is long in proportion to the face of the wheel. It is held on top by a lever set up by a screw, as shown in Fig. 3, and is mounted on a vertical pivot for slight adjustment relative to the wheel axis. The block is saw-cut to allow the water to pass to the rod. In addition, steadying rests of plunger form are employed, one on each side of the wheel. Each consists simply of a cylindrical piece with the front shaped according to the diameter of the rod, against which it is pressed by means of screw-adjusted springs. To dry the rod it is passed through a series of washers, of rubber and steel alternately, and after passing through the second set of disks the rod is automatically lubricated as it passes from the machine. To reduce the power taken, experiments are being made with a rapidly running felt drum for drying. To insure that the rod is kept rotating on the same axis, as is obviously necessary for accurate work, great care is taken when setting up the machine in the alinement of the guides and in the setting of the back rest.

A feature is the method of driving. For the emery-wheel spindle a Renold silent chain of 0.625 pitch and 2 inches wide outside, running at from 1200 to 1550 feet a minute, is used, the driver sprocket having 45 teeth and running at 510 to 670 revolutions a minute, while the driven sprocket has 20 teeth and runs at from 1150 to 1500 revolutions a minute. The disk-feed gear is driven by roller chains, the first drive being from the countershaft to the main-feed shaft, which passes inside the length of the machine, and the second drive being from this shaft to the feed disks. For the first drive the roller chain is of 0.75 inch pitch by 0.66 inch width outside, running at 100 to 140 feet a minute. Here driver and driven sprocket have 20 teeth and run at 80 to 115 revolutions a minute, while the tightener has 12 teeth. In the second drive the roller chain is 0.625 inch pitch and 0.47 inch wide outside, the speed once more being 100 to 140 feet a minute. The driver sprocket has 24 teeth and the driven sprocket 15 teeth. The tension of the feed-roller chain is adjusted by a swinging arm, the tightener for the second drive having 15 teeth. The advantages of a silent chain on the emery wheel are positive drive with constant cutting speed, while, as the chain is narrower than a leather belt would be, stiffer construction

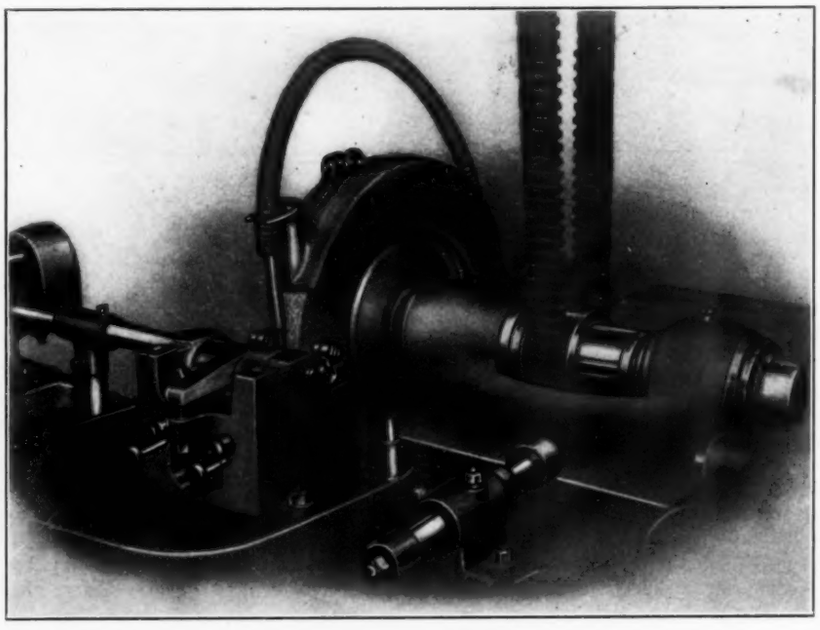


FIG. 3. WHEEL SLIDE AND REST OF GRINDING MACHINE.

is possible. Then, as the chain runs quite easily, heating and wear of the bearings are reduced, so that not only is the mechanical efficiency of the device higher, but increased accuracy is obtained. Moreover, the chain is easily adjusted, all that is necessary being to insert or remove thin packing pieces which are placed underneath the countershaft hanger base. The same advantages apply to the roller chains on the feed motions. Moreover, both sets of disks can be kept running at the same speed, as is found necessary. Also spray has no effect on the length of the chain, whereas on a leather belt it causes both stretching and slipping, with consequent lack of accuracy in the work. Readers of the AMERICAN MACHINIST will have noticed the increasing use of chains for machine-tool driving. It will therefore be worth adding that the chain-driven emery wheel is found to give perfectly smooth work, marks due to teeth continually passing into and out of action being non-existent. Finally, it should be added in connection with Fig. 2 that the chain on the left hand is shown somewhat out of position, the photograph having been taken before the machine was set up in place. The chain should run back to clear both the bar for the rod support and the job.

The Engine Lathe as a Relieving Machine.

BY F. O. HOAGLAND.

The old way of relieving taps, cutters, hobs, etc., by chipping and filing was never satisfactory, not only on account of the first cost, but because, as soon as sharpening was attempted, the correct shape of the tooth was generally lost. The more modern way of relieving by machinery was considered too costly an investment, as it formerly involved an expensive special machine, standing idle most of the time on account of the limited num-

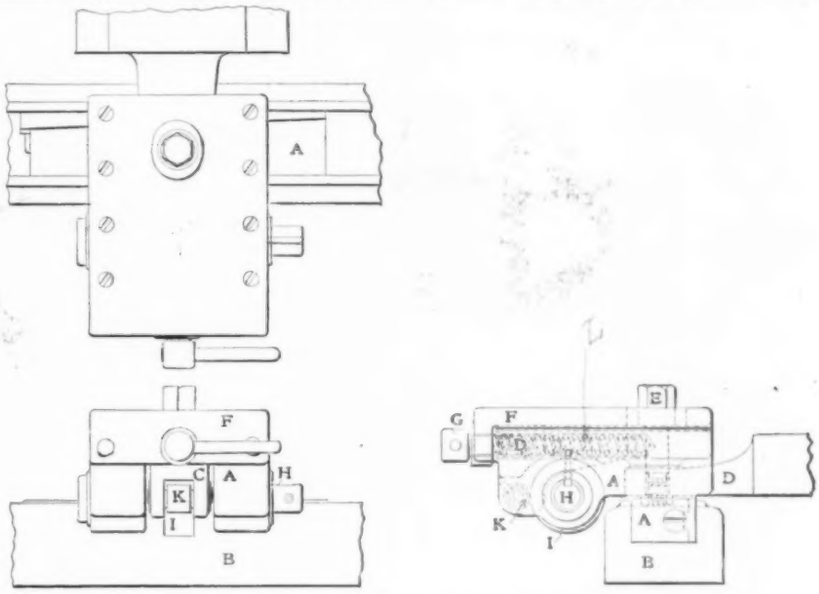


FIG. 1. THE PRATT AND WHITNEY RELIEVING ATTACHMENT.

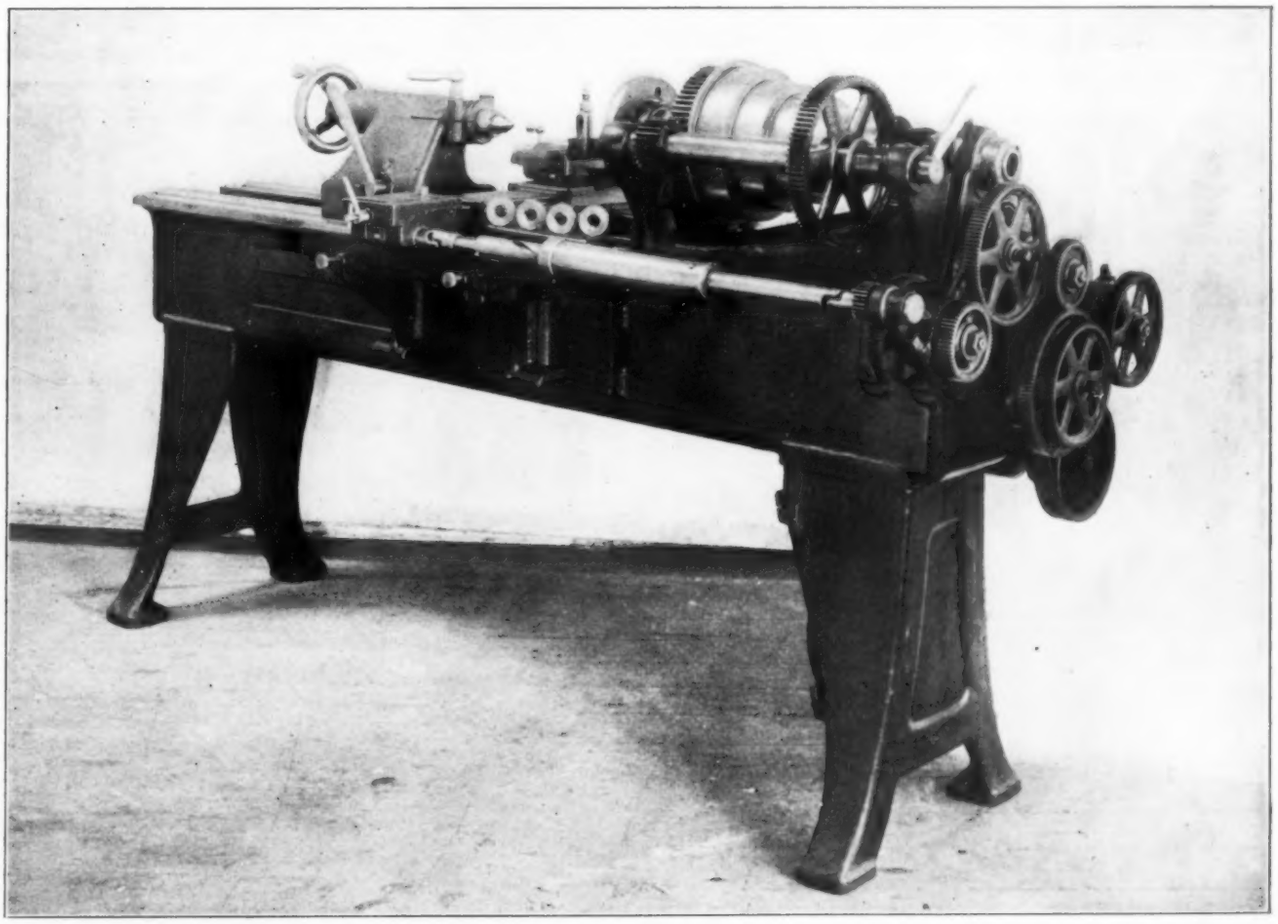


FIG. 2. PRATT AND WHITNEY LATHE WITH RELIEVING ATTACHMENT IN POSITION.

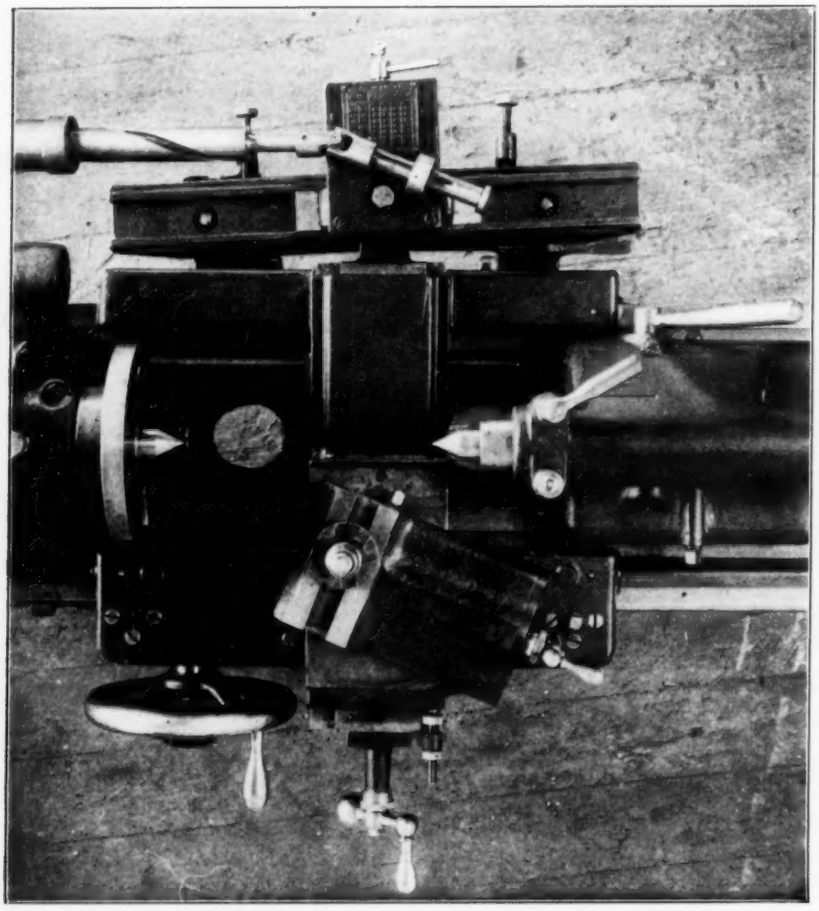


FIG. 3. PLAN VIEW OF LATHE CARRIAGE AND RELIEVING ATTACHMENT.

ber of tools made that required relieving. When finally a Pratt & Whitney relieving attachment, for the 14-inch lathe, was added to the tool-room outfit, these difficulties were overcome and many a hard problem was solved most satisfactorily.

Fig. 1 shows the construction of the attachment. The taper bar-slide or frame

PATENTED U.S.A. DEC. 2, 1902

GEARS		No. OF FLUTES OR TEETH			
DRIVING	CHANGE	SINGLE RISE	DOUBLE RISE	TRIPLE RISE	QUAD. RISE
80	120	2	4	6	8
40	40	3	6	9	12
40	30	4	8	12	16
80	48	5	10	15	20
80	40	6	12	18	24
70	30	7	14	21	28
80	30	8	16	24	32

RELIEVING

FIG. 4. RELIEVING ATTACHMENT INDEX PLATE.

A is fitted to the taper-bar *B* and carries the cam shaft *K*. The roller-slide *C* is clamped to the cross-slide *D* by means of bolt *E*, the cap *F* holding the roller-slide in position and carrying the binder-screw *G*. When the cam shaft *H* is revolved by the telescopic shaft, shown in Fig. 2, cam *I* forces roller *K* and slide *C* forward according to the profile of the cam. The

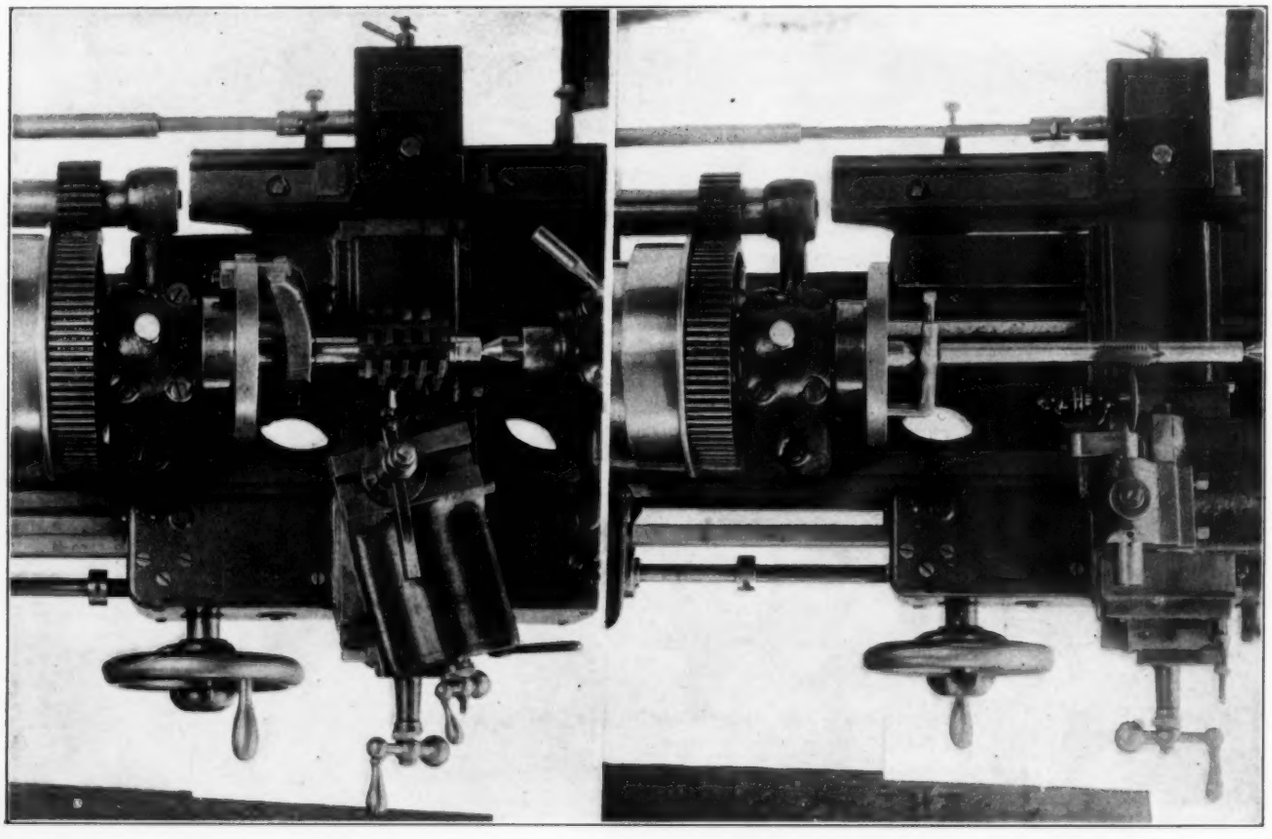


FIG. 5. RELIEVING A HOB.

FIG. 6. CORRECTING THE LEAD OF A TAP.

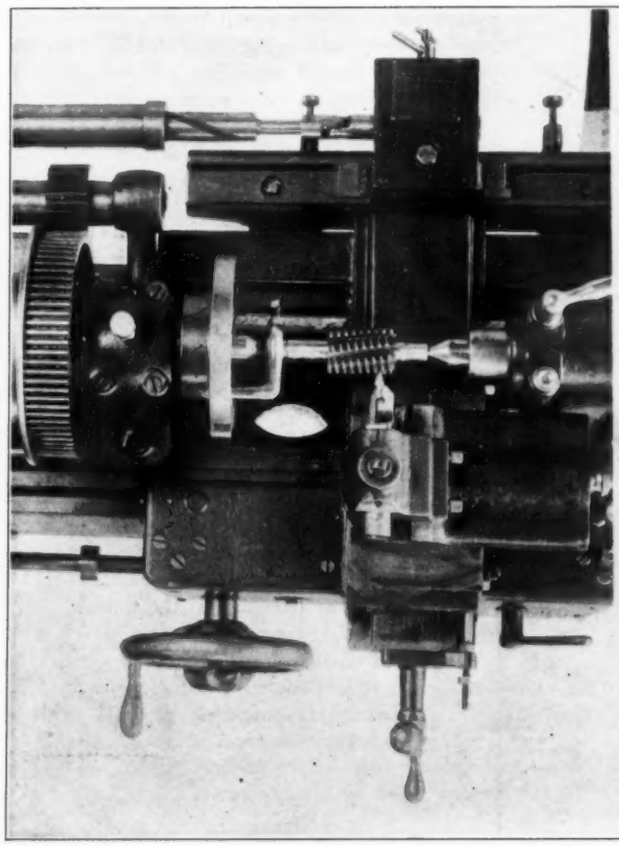


FIG. 7. RELIEVING A HOB FLUTED AT RIGHT ANGLES WITH THE THREAD.

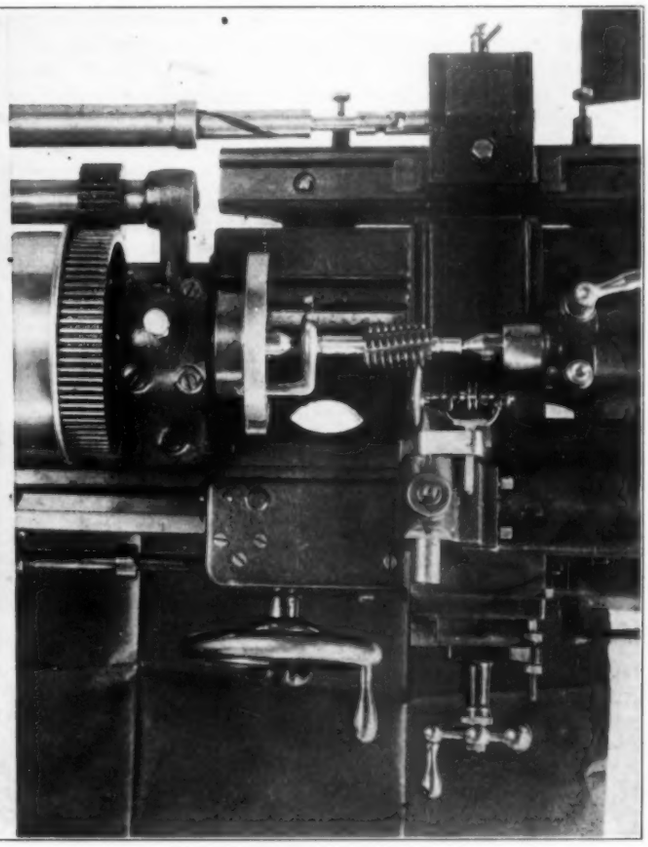


FIG. 8. GRINDING A HOB FLUTED AT RIGHT ANGLES WITH THE THREAD.

springs *L* press roller-slide *C* backward and roller *K* against cam *I*.

When the cam has to be removed, roller *K* and slide *C* may be withdrawn and clamped to cap *F* by binder-screw *G*, the relieving attachment then becoming one rigid member, in which condition it can be used in place of the regular taper bar-slide. By unscrewing bolt *E* the attachment can be removed entirely.

Fig. 2 is a rear view of the lathe with the relieving attachment and special spiral driving shaft in position, and single double, triple and quadruple cams lying on the carriage, and Fig. 3 is a top view of the carriage and attachment with the cam shaft detached.

When relieving a tap or hob in which the flutes are cut parallel with the axis a straight-grooved cam-driving shaft is used and geared so as to cause the cam to force the cross-slide forward once for every flute or tooth. The index, Fig. 4, gives the different combinations of cams and gears most frequently used.

Fig. 5 shows a large hob in process of being relieved. On account of the size of the teeth it was found advantageous to relieve the sides, top and bottom in separate operations. By setting the compound rest to the proper angles, this was done with common side and square-nose tools, a side tool being shown in the illustration.

Fig. 6 shows a tap for a lead-screw nut having its lead corrected by grinding after hardening to insure good contact of screw and nut.

Figs. 7 and 8 show the lathe arranged for relieving and grinding a job, fluted at right angles with the thread. In this case it is necessary to use a cam-driving shaft grooved spirally to correspond with the lead of flutes as shown, or a straight-grooved shaft geared to compensate for the spiral may be used.

By using cams of a different number of rises, geared according to the index plate shown in Fig. 4, the same spiral groove will do for a number of different leads of flutes.

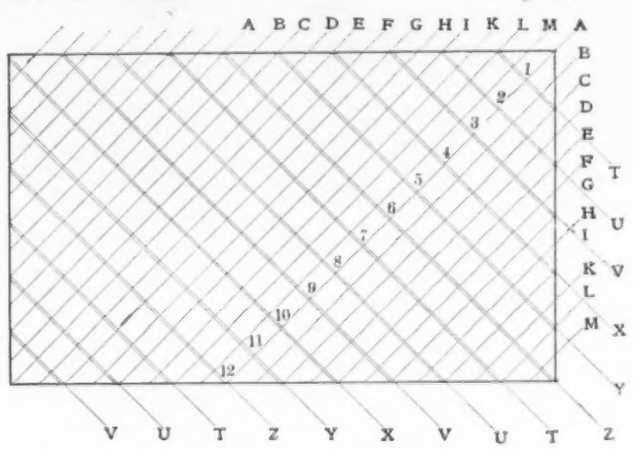


FIG. 9. WORK FLUTED AT RIGHT ANGLES WITH THE THREAD.

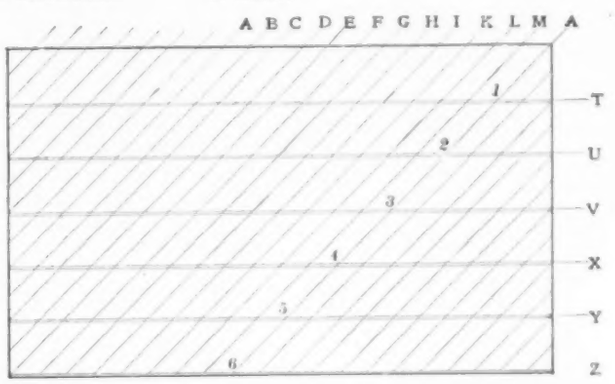


FIG. 10. WORK FLUTED PARALLEL WITH AXIS.

For example, let

A = Lead of flutes in work,
B = Number of flutes in work,
C = Number of rises on cam,
x = Lead of groove in shaft.

Then

$$\frac{A\,C}{B} = x.$$

If A = one turn in 60 inches
$B = 8$
$C = 2$

Then

$$x = \frac{60 \times 2}{8} = 15 \text{ inches.}$$

Substituting single, triple and quadruple for the double-rise cam, it will be seen that the

Single-rise cam will require one turn in 7½ inches.

Triple-rise cam will require one turn in 22½ inches.

Quadruple-rise cam will require one turn in 30 inches.

Furthermore if a shaft grooved exactly to correspond with theoretically correct lead of flute in the work, should not be at hand, it has proved practicable to select a shaft somewhat long in lead of groove and flute the work to suit. By reversing the cam and running the shaft in the opposite direction, the same shaft can be used for right- and left-hand spirals.

If the lead of the thread is very coarse, and the flutes are milled at right angles with them, it will be found preferable to use the straight-grooved driving shaft, geared to compensate for the spiral. Figs. 9 and 10 will illustrate the different conditions existing when work is fluted parallel with the axis, and at right angles with the thread. Letters A to M, inclusive, represent the threads and T to Z the flutes.

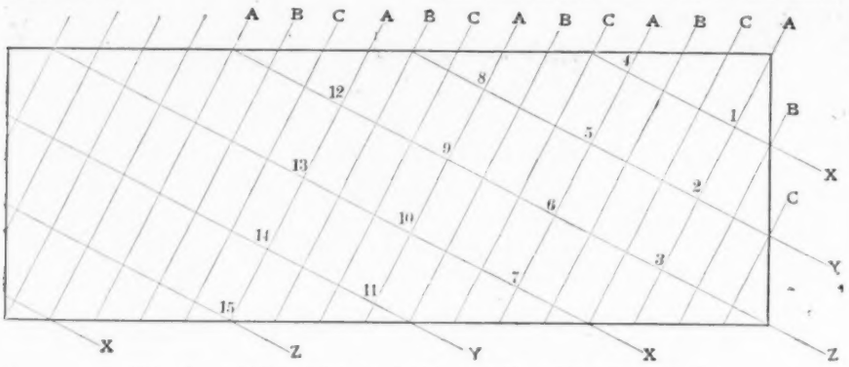


FIG. 11. WORK FLUTED AT RIGHT ANGLES WITH THE THREAD.

Following a thread as indicated by numbers 1 to 6 in Fig. 10, it will be found that the threads intersect each flute once for every turn of the work, whereas in Fig. 9 in which the work is shown as being fluted at right angles with the thread, each flute is crossed twice in one turn as shown by the figures 1 to 12, it being understood that this condition applies to the case shown only, in which the spiral angle of the thread is 45 degrees. It is therefore obvious that the cam must be geared so as to cause the cross-slide to reciprocate six times for one turn of the thread in the first instance, and twelve in the second.

In Fig. 11 somewhat different conditions are shown. Letters A B and C represent the thread, and X Y and Z the flutes. Passing along one of the threads as before, it will be found that the thread makes four turns to the flute one and intersects it 15 times, or 3¾ times for one turn of the thread.

To find the proper ratio of gears, when the straight-grooved shaft is used to relieve work fitted at right angles with the thread, the following formula will be found convenient:

Let

A = Lead of flutes in work,
B = Number of flutes in work,
C = Lead of thread in work,
D = Number of rises on cam,
x = Ratio of gears.

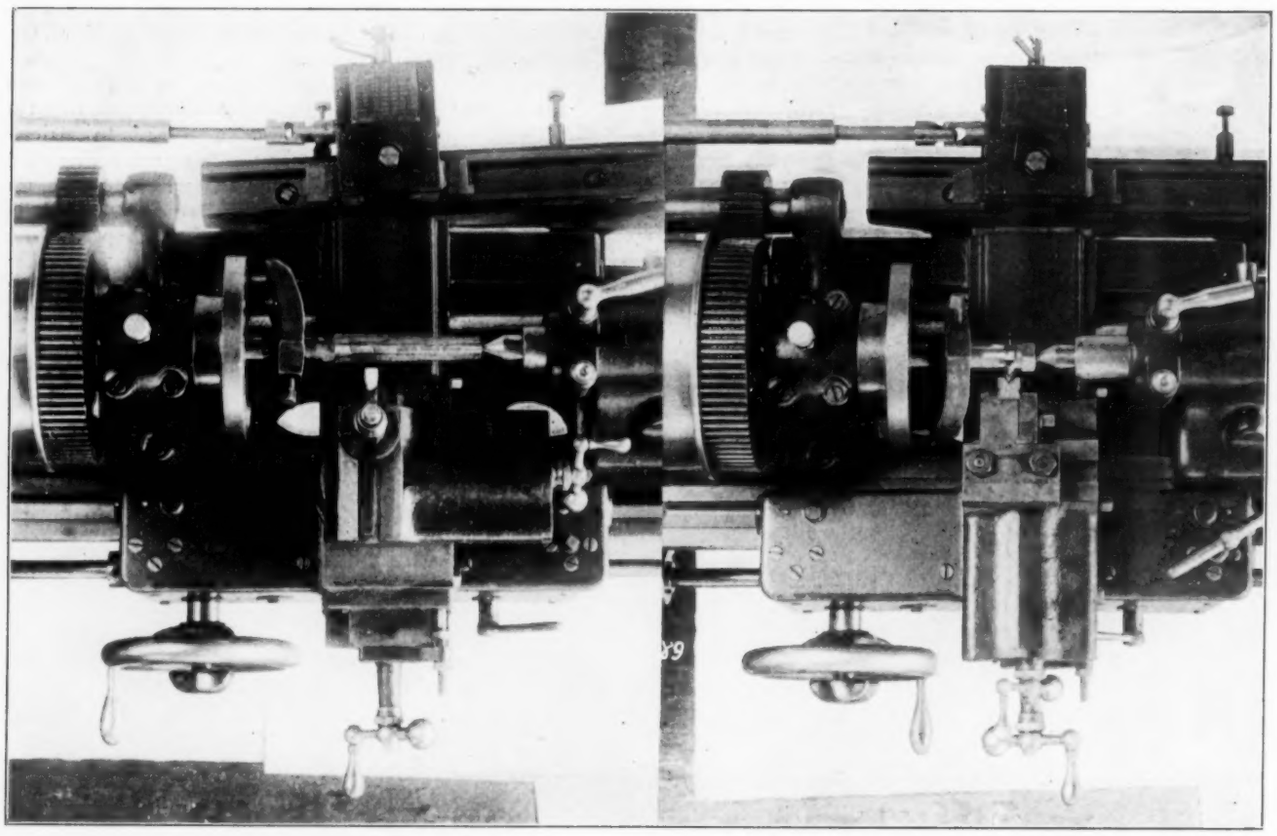


FIG. 12. STEPPING AND RELIEVING A HANSON TAPER REAMER. FIG. 13. RELIEVING A WHITWORTH STANDARD THREAD MILLING CUTTER.

Then

$$B\,\frac{(A+C)}{A\times D}=x.$$

For example, if

$A = 10.625$ inches,

$B = 3$,

$C = 0.5$,

$D = 1$.

Then

$$3\,\frac{(10\,625+0.5)}{10\,625\times 1}=3\,\frac{12}{85}$$

$$=\frac{267}{85}=\frac{89}{85}\times\frac{3}{1}$$

$$=\frac{89}{85}\times\frac{90}{30}.$$

Fig. 12 shows a Hanson taper reamer being stepped and eccentrically relieved simultaneously. The taper-bar is set on a taper of 0.6 inch per foot and the carriage is fed along the step to produce a back taper of about one degree. In the meantime each step is being eccentrically relieved.

Fig. 13 shows a Whitworth standard-thread milling cutter in process of being relieved. The illustration is self-explanatory.

In Figs. 14 and 15 are shown a special ratchet-thread milling cutter and the way it was relieved. Relieving it in the regular way, as shown in Fig. 13, the one side being at 45 degrees with the axis would have an ample amount of clearance, while the other being at a right angle to the axis would have none. By offsetting the tail-stock about one inch, and swinging the compound rest with the tool to correspond, the latter when forced forward by the relieving cam will pass sideways, and relieve both sides of the cutter in such a way that when sharpened in the regular manner by grinding the faces of the teeth, the correct shape will be maintained. On account of the centers being out of line, the common lathe dog would slide in and out of the slot in the face-plate, advancing and retarding the cutter, and to overcome this a pair of bevel gears were mounted on the

FIG. 16. SPECIMENS OF RELIEVED WORK.

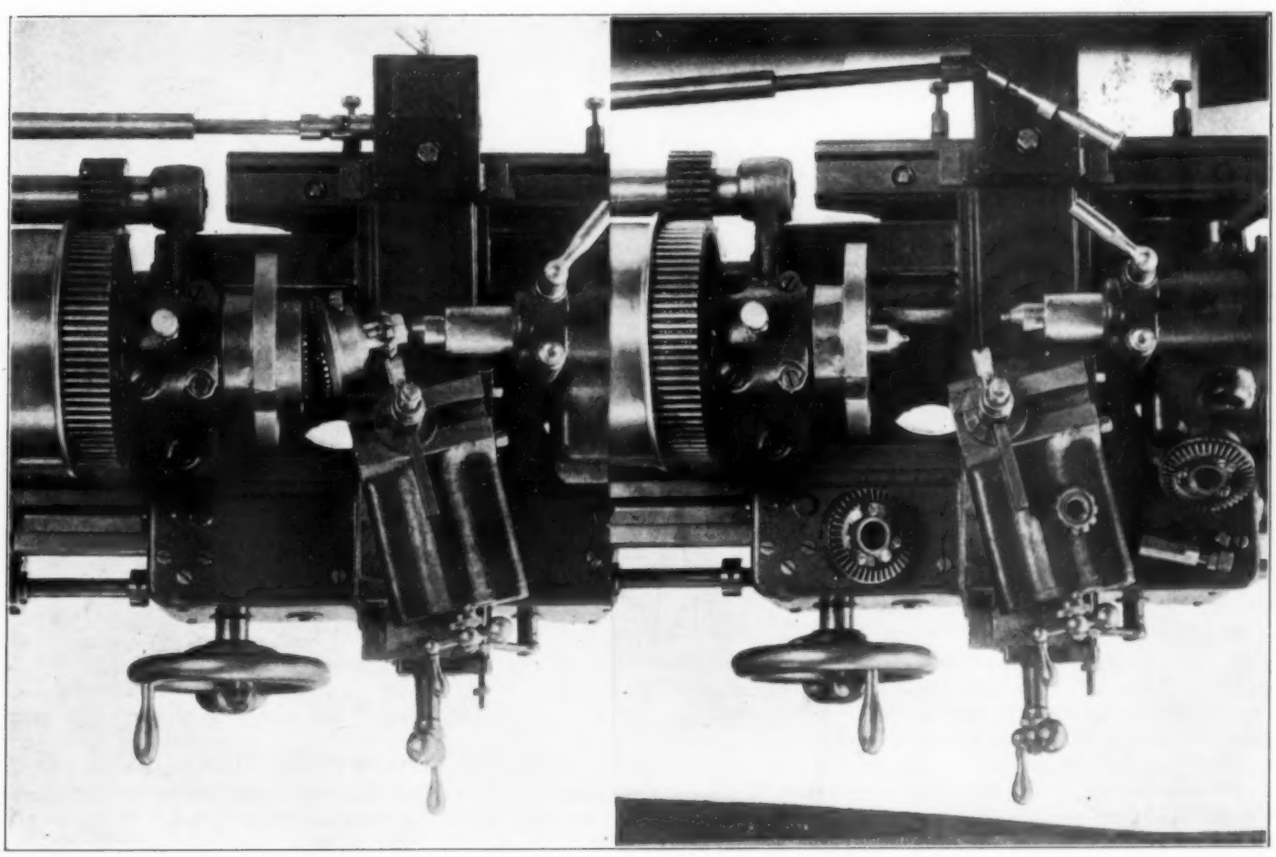


FIG. 14. FIG. 15.

RELIEVING A SPIRAL RATCHET THREAD MILLING CUTTER.

arbor and face plate respectively, causing the driving to be done at one side only, and the lathe spindle and the cutter to revolve uniformly. A pair of ball-pointed centers completed the outfit.

Fig. 16 gives a few specimens of work done.

In making ovals or square punches and dies similar to the washers shown in Fig. 16, the relieving attachment will be found very convenient, particularly since, by swinging the taper-bar or the compound rest, the desired clearance can be made without re-setting the work.

As the relieving attachment does not interfere with the use of the taper-bar on the compound rest, it has proved very universal, in fact, has both relieved and turned out a great variety of work, such as elliptical and polygonal, cylindrical and taper male and female.

According to a paper delivered before the members of the Boost Club by J. A. Walker, vice-president of the Joseph Dixon Crucible Company, a girl was the first maker of lead pencils in America. She obtained some pieces of graphite from a mine in England, and in some way crushed this graphite, either with a hammer or a stone, and then mixed it with gum. She put this mixture into an alder twig, from which she had removed the

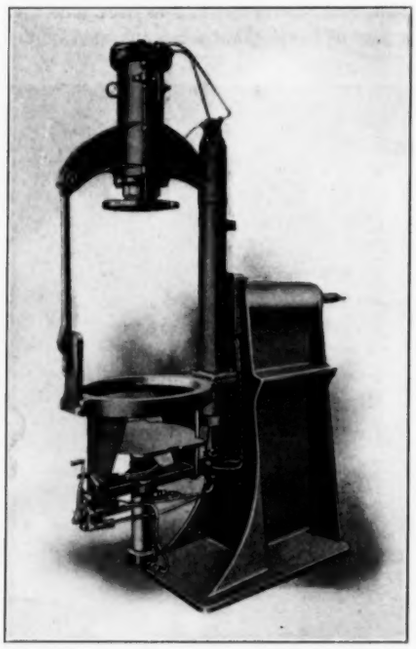


FIG. 1. ROTATIVE MACHINE R-3 IN NORMAL POSITION WITH RAMMING CYLINDER UP.

pith, thus producing the first lead pencil made in America. This took place in Danvers, Mass., and later a man by the name of Joseph W. Wade co-operated with this girl in the making of pencils in the same manner, but the name of the girl, Mr. Walker says, is not known. Henry D. Thoreau, of Concord, also was among the earliest pencil makers in this country, but he did not pursue it.

The Bonvillain Rotative Molding Machine.

Founders in charge of molding machines have met the case of castings with deep pockets, and are aware of the difficulty of turning out such work quickly, especially when there is little or no taper. In most cases this style of casting has to be made by hand and much trouble is experienced in drawing the patterns without breaking the sand in some places, which causes a loss of time for patching, often greater than the time required to ram the mold. Some of this work can be put on the "roll-over" machine. Trouble, however, is experienced in drawing the pattern plate to permit the roll-over motion, causing the breaking of the sand. The difficulty of maintaining accuracy in the pins with the constant clamping and unclamping operations is not conducive to accuracy in the molds made by this process. It is almost impossible to make on this machine thin hardware castings, like pots, pans, and the like, for the thickness is likely to be uneven, which point is very important in castings having no more than 3/32- to ⅛-inch thickness. Furthermore, the pattern plates for this machine are costly and it is impossible to use strippers and stools, and it is very unhandy to use power ramming.

We published some months ago (Page 718, Volume 28, Part 2; Page 11, Volume 29, Part 1) some articles on a new system of hydraulic machine molding. The makers of the machines therein described (Messrs. Bonvillain and Ronceray, Paris, France) have devised a new machine, which they call a "Rotative Molding Machine," which is very interesting, and with which some remarkable results have been obtained. The machine is, in its main lines, very similar to the standard Universal machine, and, in fact, it can be used for ordinary work exactly as the other; but for molding castings with deep cores, when the pressure is applied to squeeze

FIG. 2. ROTATIVE MOLDING MACHINE R-3, TURNED TO REVERSED POSITION WITH STRIPPING CYLINDER UP.

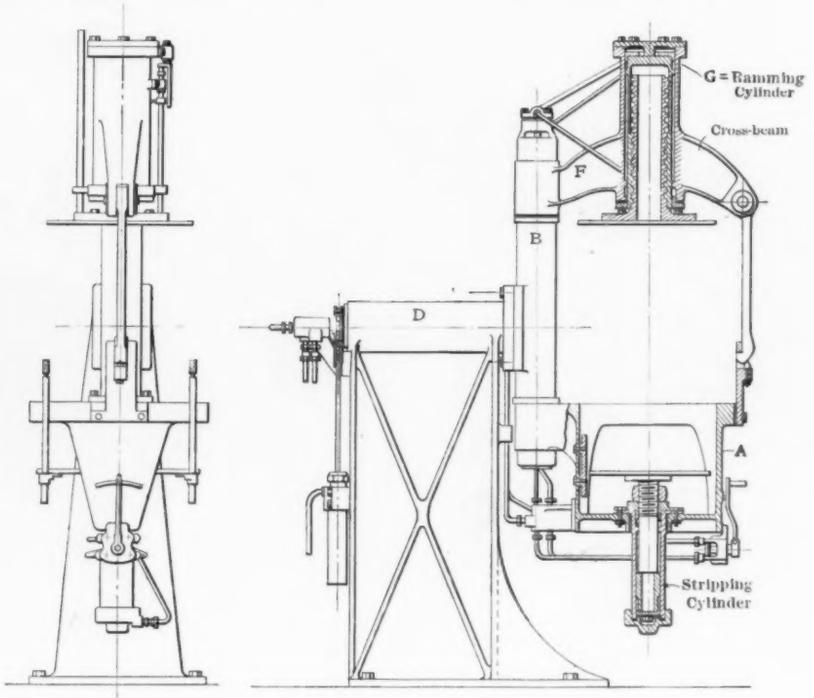


FIG. 3. R-3 ROTATIVE MOLDING MACHINE.

the mold, the whole machine is caused to revolve to an upside-down position, so that the ramming or squeezing plunger will now be underneath; this cylinder is then put to exhaust and the ramming plunger goes down, causing the mold also to go down, and thereby effecting the drawing of the pattern. At the same time the opposite plunger, which is now on top, is given traverse and causes the stripping plates, stools, etc., supporting the sand in weak points to follow the mold downward and to stop when there is no more fear of breaking the sand. This machine permits of the turning out of much more difficult molds, some of which are illustrated in this article.

The process of executing them will probably be better appreciated after reading the description of the rotative machine which we will now give. Fig. 1 is a view of the R-3 machine in its normal position with the ramming cylinder above. Fig. 2 is a view of the same machine turned to reverse position, with the ramming cylinder below and the stripping cylinder uppermost. The table in this machine has a diameter of 620 millimeters; maximum distance between table and pressure or ramming plate, 750 millimeters; stroke of squeezing or ramming plunger, 335 millimeters; of stripping plunger, 150 millimeters. There is also a smaller rotative machine made, designated as R-4, and similar in design to the R-3, except that the cylinders are connected together merely by the column, there being no hook-rod to tie them together. The R-4 has a table 460 millimeters diameter, maximum hight to ramming plate of 600 millimeters, ramming plunger 260 millimeters stroke, and stripping punger 150 millimeters stroke.

Fig. 3 is a drawing of the R-3 machine in its normal position, showing the cylinders in section. The table *A* is strongly secured to the column *B*, to which is bolted a hollow stud supported by a housing *D*. The column *B* is bored to receive a tube which acts as a pivot for the cross-beam *F*, in which is bored the ramming cylinder *G*, which is made of extra length on account of the special deep work for which the machine is intended; the length of the ram or plunger is adjustable by means of a screw. The return motion of the plunger is obtained by hydraulic pressure acting constantly upon an annular portion of it and thus causing the return stroke when the other side is connected to the exhaust. The machine is arranged with an automatic stop in the return motion, so as to save time and water in operation. The cross-beam can be swung a quarter of a revolution about the vertical axis of the column, so as to permit of putting sand in the flask, and also to put the mold to the side of the machine and to hoist it by mechanical means in case it is too heavy to be lifted by hand. The arrangement of the table is very similar to that described in the first article on the "Universal" system of molding, but in addition the plunger has a return motion, and both sides of it can be put to exhaust, so that it may fall down by its own weight.

When used as a universal machine the table is down and the cross-beam is up, and the operation of the machine is exactly the same as that of the standard universal machine. Molds are drawn from

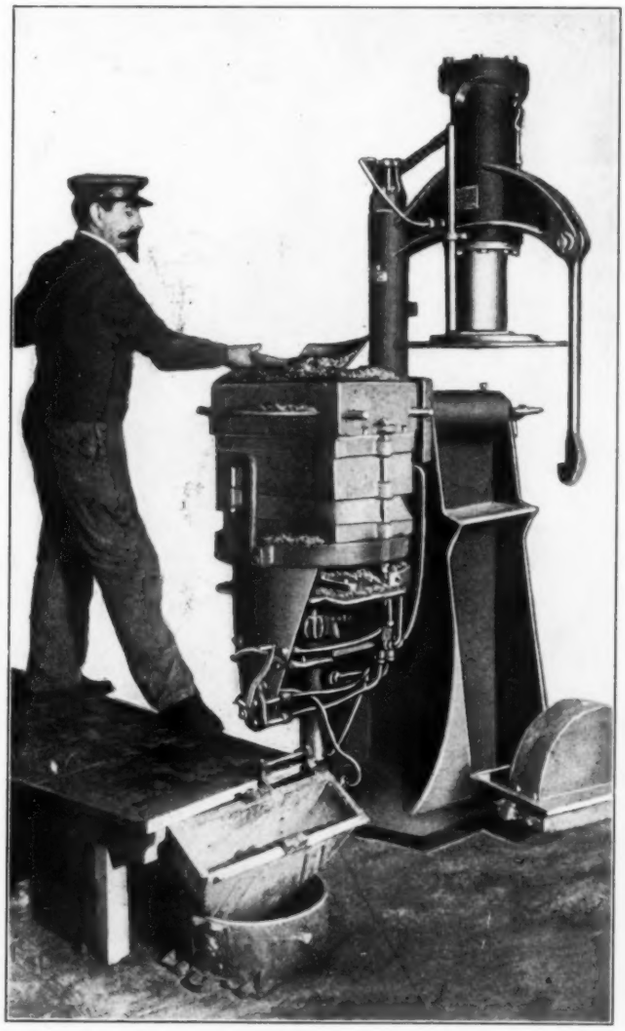


FIG. 4. CROSS-BEAM SWUNG ASIDE; FLASK SETTING ON PATTERN BED; FILLING MOLD WITH SAND.

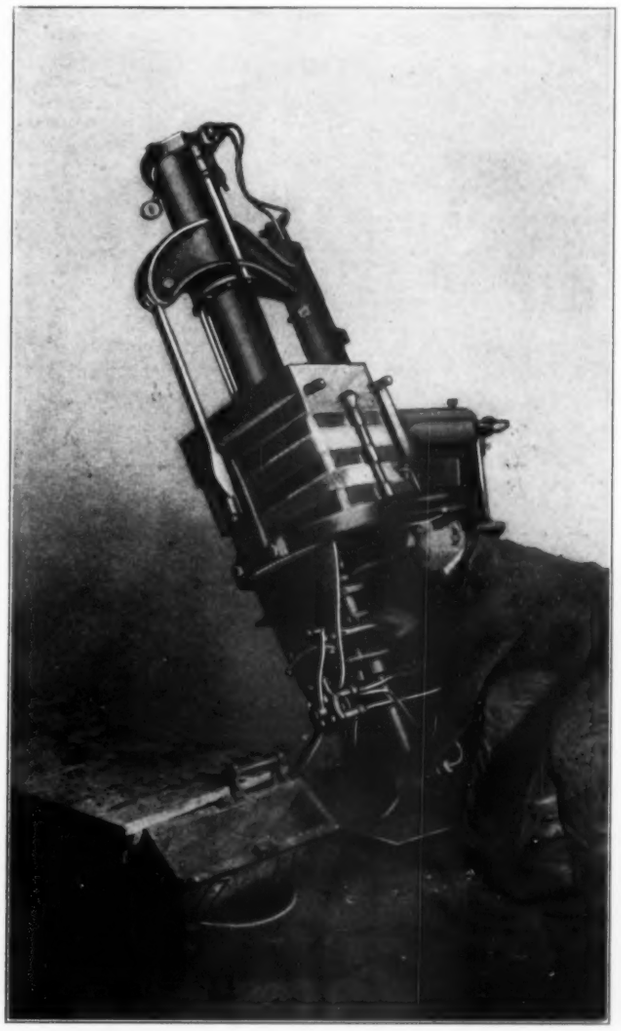


FIG. 5. RAMMING PLUNGER PRESSING ON MOLD; MACHINE BEING ROTATED TO REVERSED POSITION.

the pattern plate by means of lifting rods and stripping plates, stools are used exactly in the same way in both machines; but when used for deep castings, the working of the machine is different. This can be best made clear by following through a representative operation as shown in the series of pictures, Figs. 4 to 9, inclusive.

The pattern plate is fixed to the table, the flask is put in position and the length of the adjustable plunger is regulated so as to come just at the level of the upper edge of the flask when at full outward stroke. The cross-beam or head piece is then turned to the right and sand is put in the flask, as shown in Fig. 4. An extra quantity is added according to the class of the mold, the cross-beam is turned back to its normal position and pressure is applied by pulling the lever so that the ramming plate is brought down to, and presses on, the mold. The whole machine is then revolved one-half revolution about a horizontal axis, which is being done in the view Fig. 5. The controlling lever for the ramming plunger is then put to exhaust position and the pressure is at the same time applied to the small or stripping plunger, which is now uppermost. The ramming plunger falls back into its cylinder and the small plunger does its part in loosening the mold by following the inside stripping plates, stools and various pieces used to help the sand to get out. As soon as the mold is out of danger, that is, as soon as all chances of breakage have disappeared, this plunger and the pieces attached to it are stopped, and meanwhile the other piston continues to fall down. Fig. 6 shows this stage of the operation. In Fig. 7 the large piston has gone all the way down and the man is undoing the hook preparatory to removing the mold from the machine. The heavy core part of the mold is resting directly on the mold and ramming plate, so that there is no tendency for it to break. In Fig. 8 the man has got the hook released and has pulled the cross-beam (which is now below) around to the left, so as to make it easier to get at the mold and lift it off. In Fig. 9 he has, with the assistance of a helper, accomplished this last step, leaving the machine free to be turned back again to its normal position, upon which the small or stripping piston will fall down and take its first place, carrying with it all the movable parts of the pattern plate, which again come into their proper position in the plate proper.

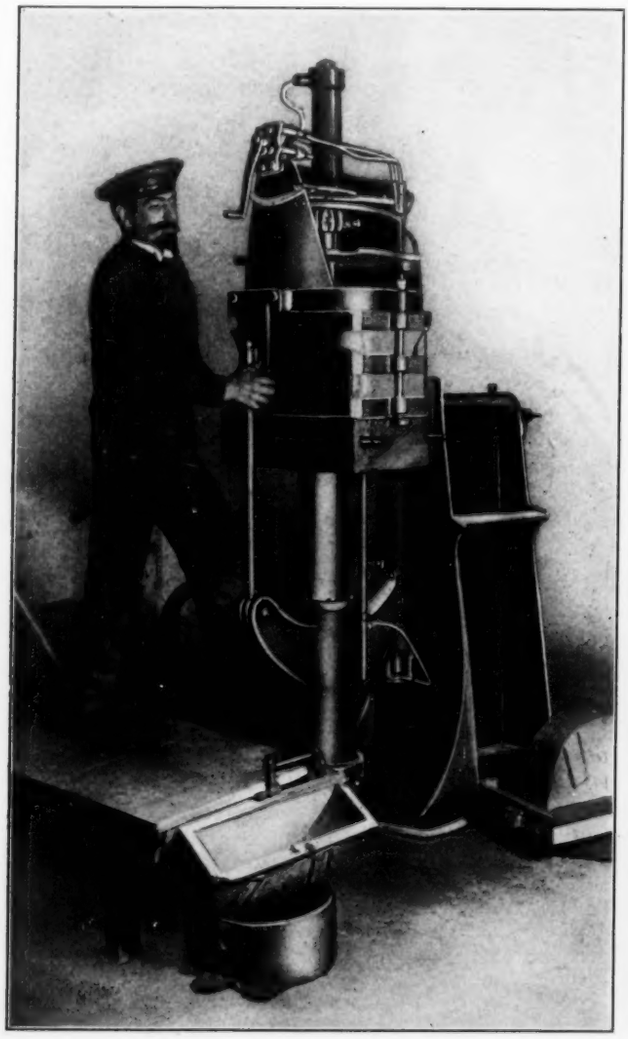


FIG. 6. SMALL PLUNGER LOOSENING STRIPPING PLATES AND STOOLS; RAMMING PLUNGER SIMULTANEOUSLY RETREATING.

FIG. 7. LARGE PLUNGER AND FLASK ALL THE WAY DOWN.

EXAMPLES OF THE WORK OF THE MACHINE.

We will now illustrate some of the jobs done on this machine.

Fig. 10 shows such a casting with its pattern plates. The bottom of the drag plate is formed by the stripping plate shown, which is fixed to the table plunger, being adjusted to follow the mold for a certain portion of the stroke, and then to stop. The ramming of the mold is accomplished as already described. The table plunger having both sides connected to exhaust while the ramming plunger is under pressure, the machine is then revolved 180 degrees and the ramming cylinder put to exhaust, the mold is lowered, the stripping plate keeping the sand in place, and stopping when there is no longer danger of the sand breaking, and the mold continues to go down until the core has got free from the pattern plate, when the mold can be removed. It may be remarked

that loose parts are numerous in this pattern. Their weight assists their motion with the mold; and during this motion they may be taken out, so that when the mold is removed from the machine, it is entirely completed.

Fig. 11 is from a photograph showing the operation of drawing a mold for a railroad axle box of open type. The machine is in the reversed position with the small cylinder above and the large cylinder below. The pattern can be seen bolted to the table and below it is the flask containing the mold. In this mold, in addition to the central stripping plate, there are two cylindrical cores to be drawn, and another core for the cover having a recess on the side. The cylindrical cores are pushed by the small blocks of metal fixed to thin rods attached to the table ram. The cover channel for the dust-proof ring is pushed in the same way, the shape of the pusher being of course different, and arranged to start the loose pieces making the recesses of this core. This mold is a nice piece of work.

There is a lot of work suitable to this machine, including hardware, step cones for machine tools and various castings for automobile and machine-tool work, a few of the latter class of which are illustrated; and generally speaking, all molds which have a heavy projecting part may be satisfactorily executed upon it. Figs. 12, 13, 14 and 15 are examples.

For making the castings shown in Figs. 16 and 17, it is advisable to use two machines, one of the universal pattern described in the first paper, which is to serve for making the cope, and one rotative machine for making the drag, as this part of the mold has the heavy core which makes the inside of the castings.

The group of castings shown in Fig. 18 was made on one A-5 (universal) machine, and the points of interest are the very peculiar shape of the stripping plates used. The stripping plate is not only a stripping plate, but the parts of it marked *A A A* in Fig. 18 are also parts of the pattern, and the parts marked *B B B* are parts of the core print. It is also interesting to note that the reversible system is here used, that is, one pattern plate only is necessary for making the complete mold, both cope and nowel.

It will be plain that in the use of the rotative machine, there is an operation which is not required in using the universal machine. It might be supposed that the rotative is not as rapid as the universal machine; nevertheless it has been found that in making drags on the rotative and copes on the universal, the man working on the rotative machine is in 90 per cent. of the cases in advance of the man working on the other one. Where heavy loose pieces are used, this machine will unquestionably give a saving of time; as such pieces are very likely to fall down when the mold is drawn the reverse way.

It has been found advantageous to use this machine for work where it is necessary to obtain a very nice skin, as for metals, artistic work, etc. In such work it is the practice to powder the molds with "poncif," and to ram again, this being done a number of times so as to obtain a nice skin and to avoid carving work. The mold being rammed in the usual way, and the machine revolved, there is every facility for powdering the mold and giving as many additional rammings as may be necessary

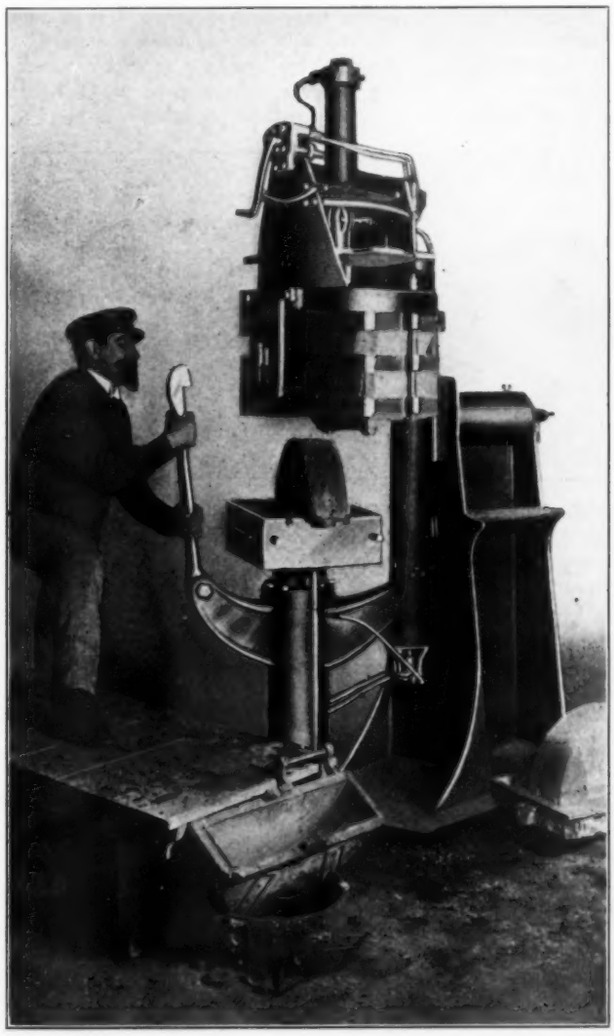


FIG. 8. HOOK RELEASED, CROSS-BEAM CARRYING THE MOLD SWUNG TO THE SIDE TO CLEAR THE PATTERN AND FACILITATE REMOVAL.

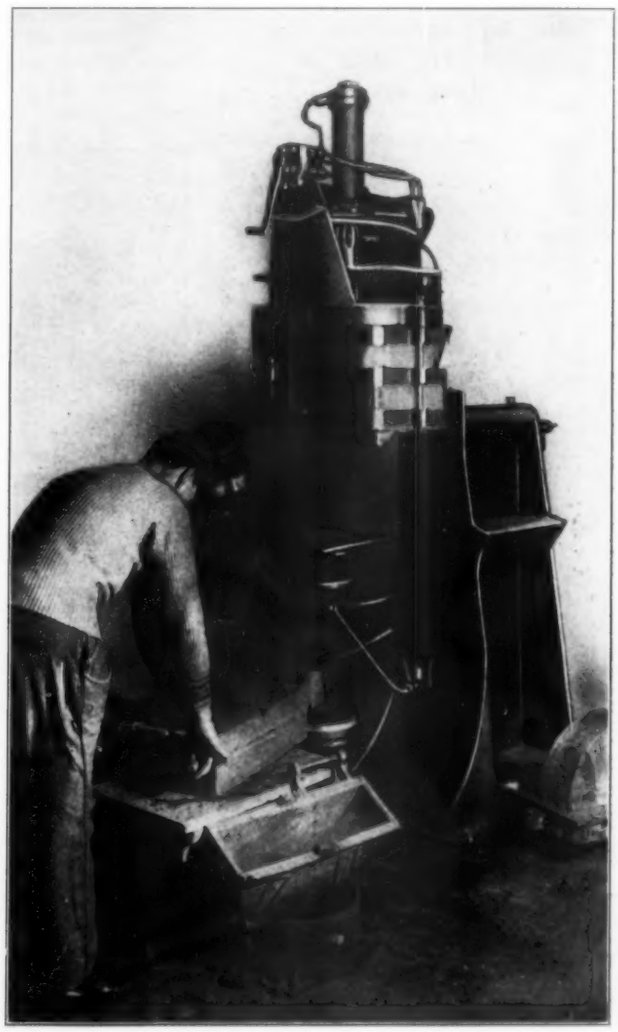


FIG. 9. THE MOLD LIFTED OFF THE MACHINE.

Splendid medals have been obtained by this method.

Fig. 19 shows one of the hydraulic pressure pumps made to accompany these machines. The one shown has a double-acting plunger, and is belt-driven; they are also made single-acting, and may be provided with electric motor mounted on the same bed-plate. The plunger has a diameter of 30 millimeters and stroke of 55 millimeters; the single-acting machine will deliver 275 liters (73 gallons) per hour, and the double-acting twice as much.

Friction, Useful and Otherwise, in Machines and Men—Opportunities for Apprentices and Others—The Ideas of Long Ago.

BY E. R. PLAISTED.

Friction, like fire and water, is a good servant and a hard master, and did it ever occur to you just how great a part of the time and effort of machinists and designers is directed toward its control, driving it out of one place and concentrating it in another? It is as necessary in some parts as it is detrimental in others, which proves there are both good and bad sorts of friction. We want just as little of it as possible at the crank pin and the piston, but without a due allowance of it at the tread of the driving wheel all our plans miscarry and the machine refuses to budge.

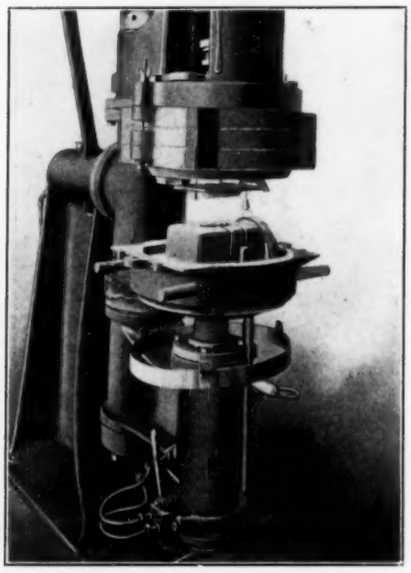


FIG. 11. MACHINE IN OPERATION OF DRAWING RAILROAD AXLE BOX; PATTERN ABOVE; FLASK AND MOLD BELOW.

Reducing the problem of machine design and construction to its lowest terms, it becomes little less than getting some surfaces to work freely on each other and getting others to grip with certainty and precision.

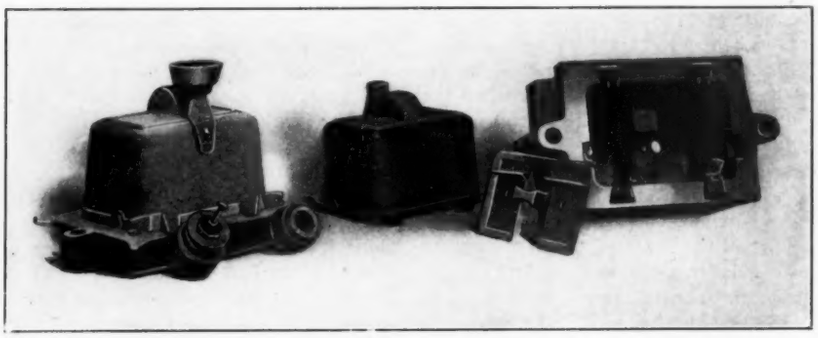


FIG. 10. FLUSHING TANK CASTING WITH DEEP POCKET, AND PATTERN BEDS.

But I have no idea of tackling such an abstruse problem as mechanical friction in dog days; even up here in the woods the weather is quite too "lassitudinous" to encourage that sort of thing outside of business hours, and it is the useful and harmful kinds of friction among men that I purpose to deal with. Every time I sign my name to an article for the AMERICAN MACHINIST I wonder if I will ever think of anything more that will be worth writing about, and I don't believe I would if it wasn't for reading the other contributions, some of which set up a frictional activity in the convolutions of my cerebrum. This is merely another evidence of my laziness; I have to be prodded before I can even think in sultry weather.

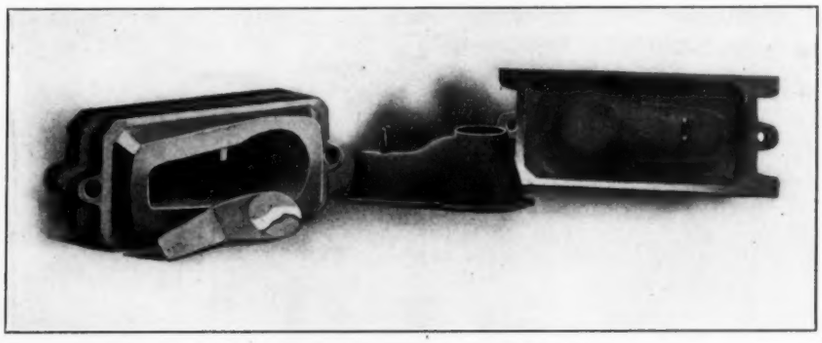


FIG. 12. BEDS AND CASTING WITH DEEP POCKET.

There is also the other sort of friction in humanity, as in machines; the kind that sometimes develops in the crank-pin brasses, and in men as well as in machinery, it often generates dangerous heat and may even cause "rucking" if the proper

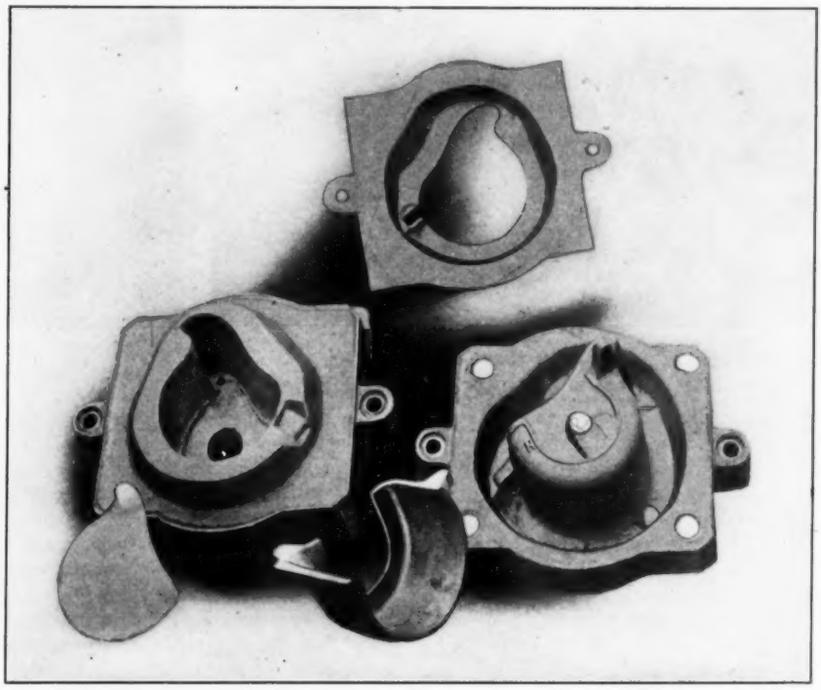


FIG. 13. THE PATTERN PLATES AND THE CASTING FOR A GEAR COVER.

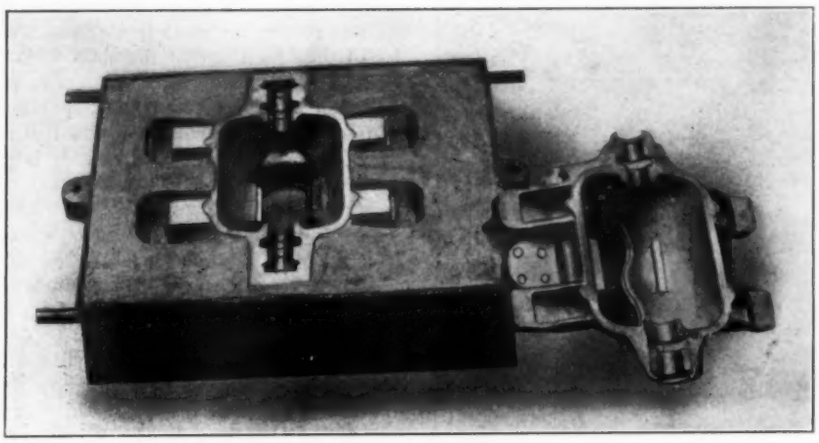


FIG. 14. CASTING AND ONE OF THE PATTERN PLATES FOR CRANK CASE FOR 2-CYL. 12-H.P. MOTOR.

lubricant be not applied in season. But funny part of it is this: it seems easier to prevent, conceal, or cure manifestations of this sort in the machine than in the man. Perhaps that is because, as someone aptly remarks, what is a beastly temper in the other fellow is only righteous indignation in ourselves. You see it depends entirely, as in the case of the 6x9 perpetual motion, on the point of view.

This time it is Entropy who has done the sandpaper act to my thinking apparatus, and by the way, I wish he would be a little more frank with us when he appeals for light on such matters as shop ethics. It is a bit uncomfortable and humiliating to find one's self in the pose of giving advice of that sort to a man who has done what it seems he has, though I believe I had the saving grace to hint at the time that he was not in need of any more illumination than he already possessed.

No matter whether he had succeeded or not in making a home for himself in the country by the plan he describes at page 93, we can't help admiring the courage of a man who even undertakes such a feat. It has been written about before, but usually by those who were telling how they would do it and not how they had done it. And only a man blessed with a wife who possessed a sublime disregard of "what the neighbors will think" would have had the heart to make the trial. When your nearest neighbor is over on t'other side of the mountain, and in precisely the same boat as yourself, the case is vastly different. It is lots more fun to be a pioneer when pioneering is in fashion, than when the only "correct thing" is to do just as people across the street are doing, and to buy the things they buy. My sincere respects are here offered to any man who, in spite of the trend against individuality and the pull of business connections toward town life yet has the courage (I 'almost said the audacity) to swim counter to the current and become a twentieth century pioneer.

I presume Entropy is right in thinking much that is printed in *The Philistine* has been said before, and perhaps said better, but Fra Elbertus adds an emphasis of his own that makes these sayings stick in the mind, a quality not held by some greater writers. Speaking of individuality and independence of thought gives me a beautiful opportunity to fire another quotation, though this time not exactly from Fra Elbertus, as it fell from the lips of Joaquin Miller while the Fra was paying him an afternoon call.

Some mention was made of books and the poet of the Sierras replied: "Books? What would I want with books? To hell with books! Books are for those who cannot think." Now this is being emphatic with a vengeance and grossly overstating the case besides; but there is a beautiful truth hidden under that rough husk of expression.

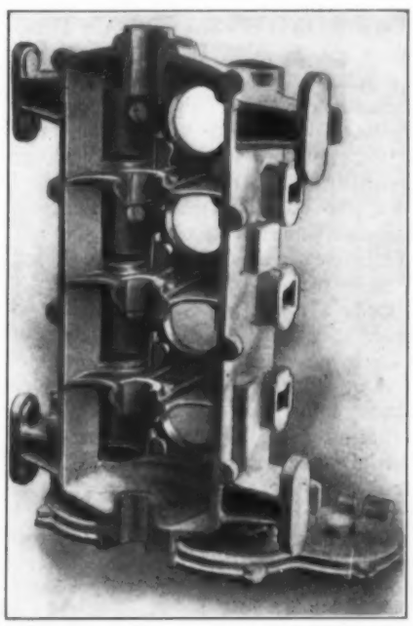


FIG. 16. CRANK CASE FOR 4-CYL. MOTOR.

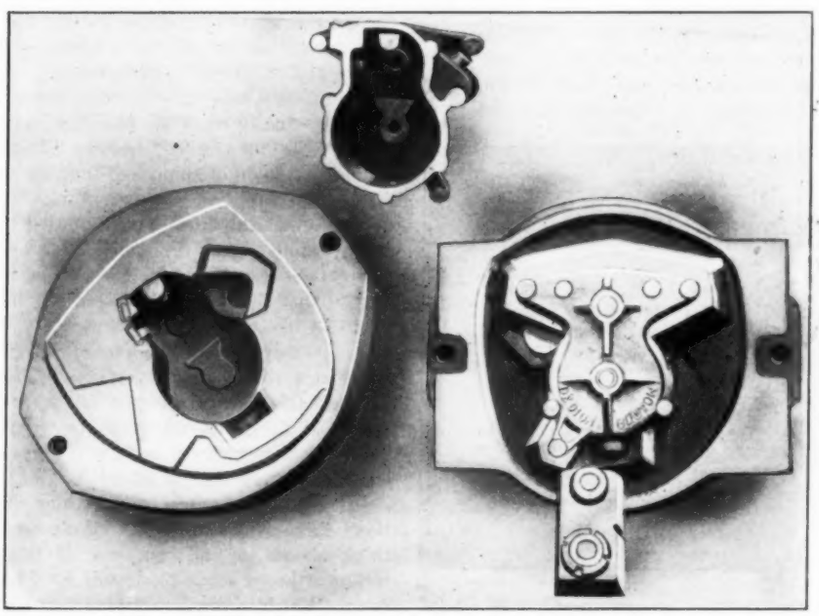


FIG. 15. PLATES FOR MOLDING CHANGE GEAR CASE CASTING.

When Entropy says he wishes Mr. Graham had admitted the environment of the average apprentice was not conducive to finding things out for himself (in other words, conducive to thinking), I trust he isn't insinuating the condition is appreciably worse than it has been for a good while, for nothing stirs me up like harping on the theme of the Good Old Times. There is no denying that if an apprentice, or any other beginner, inclines to accept and depend upon the bound volumes of other people's ideas instead of having thoughts and ideas of his own, and to apply a ready-made solution to his problems in place of working out one for himself, he has more of a chance to indulge this slipshod propensity now than formerly; so to that extent Entropy may be right, but I should be inclined to put the blame on the boy and not on his surroundings.

I haven't had time to read the several articles on apprenticeship that have lately appeared, and am not well enough in-

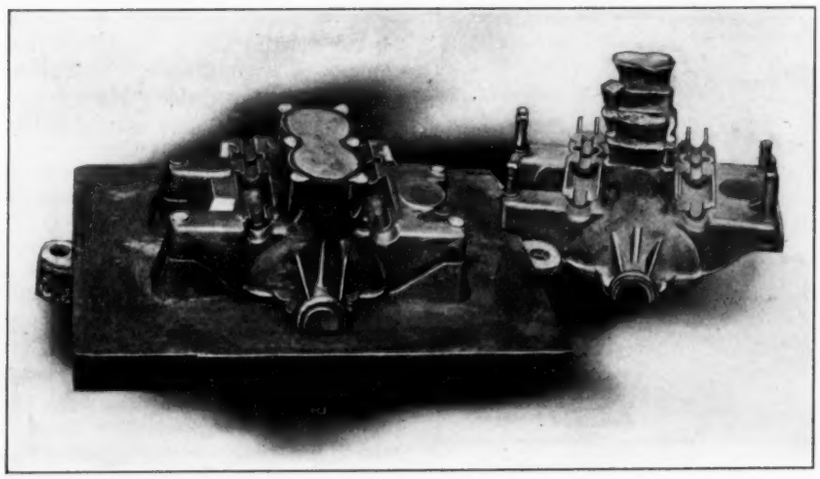


FIG. 17. CRANK CASE CASTING AND ONE OF THE PATTERN PLATES FOR 2-CYL. 12-H.P. MOTOR.

formed as to conditions out in the settlements to say much about this business, but perhaps a chapter out of my own experience as an apprentice may be worth relating.

It could have no more fitting beginning than a tribute to the memory of my old boss, whose kindness made the thing possible and who never spoke harshly to one of his men unless there was good and ample reason.

Quite a liberal slice of my term was spent at a rickety little Pond lathe of 10-inch swing and well nigh worn out. The work I got was such as is now done almost entirely on the Springfield turret lathes—studs of all sorts, coupling bolts, special screws and handles by the hundred. As it was mostly a case of duplicating the same thing day after day, it would not seem exactly or peculiarly conducive to thinking; but here, again, my laziness was my salvation, for I got heartily sick of hand-tooling those handles in the speed lathe and my eye was not pleased at the lack of uniformity they presented. First I did a heap of thinking, then considerable sketching, and next some whittling; finally I told the boss I believed I could rig up that lathe so it would turn handles that were alike, would need no emery-cloth finishing, and that I hoped also to be able to increase the output. As soon as he was convinced my ideas were sound he said go ahead, and also gave me permission to replace the solid nut on the lead screw, which was at the back side of the lathe, with a split nut working by a lever at the front of the apron. You can bet I was a happy cub.

I made my own patterns, and as the shops were running nights just then on some rush orders, I was allowed to come in after supper and do my own planing. All the shop was watching to see how the kid's newfangled notion was going to turn out, and I did not lack for advice, some of which I found helpful and some of which I didn't.

As I look back on it through the vista of 20 years it seems very crude, both in design and workmanship, *but it went*, which was the principal point to be considered just then, and I was a proud cub when the boss fetched along the proprietor to watch my hog-nosed tool automatically following the curves of a die clamped to the tailstock, turning out handles that bore a family resemblance to each other and so smooth that hand tooling and emery cloth were not needed.

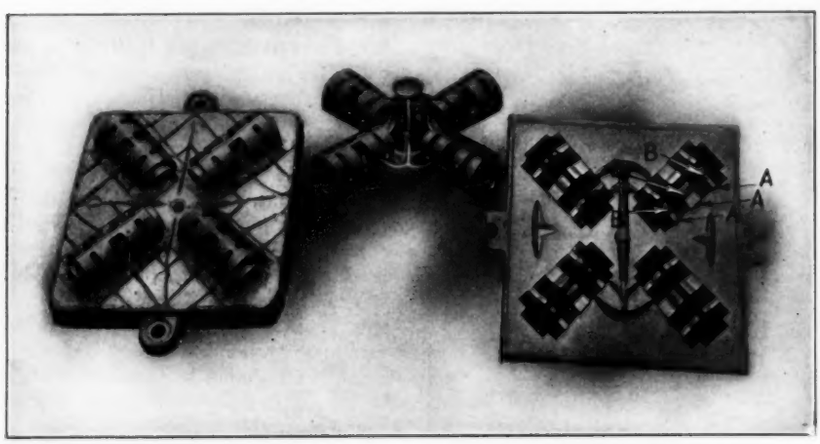


FIG. 18. GROUP OF COCK CASTINGS, PATTERN PLATE TO LEFT, STRIPPING PLATE TO RIGHT, MADE ON ONE A-5 MACHINE, REVERSIBLE SYSTEM.

When the turret machines arrived this rig was sent to the scrap heap, though, as I had then been out of the shop several years, I did not take much interest in its fate; but at last accounts that split nut that I sat up nights to make was still in use. And as no patent leathers of later years ever gave the delirious ecstasy of my first copper-toed cowhides, so no later work in designing has afforded me the satisfaction that was mine when I was able to show the shop that the kid's newfangled notions were in working order and ready for regular business.

Such opportunities have passed away, along with the conditions which gave rise to them; but there are plenty of bigger and better ones lying in wait for the cubs of today, if they but realize it. And those same correspondence schools that I recently aired my grudge against are a tremendous factor in the case. The cub rather enjoys seeing his name in handsome handwriting on a big envelope with a big ad in the corner, but the middle-aged man who has had to scratch hard for his schooling, and worry along with but

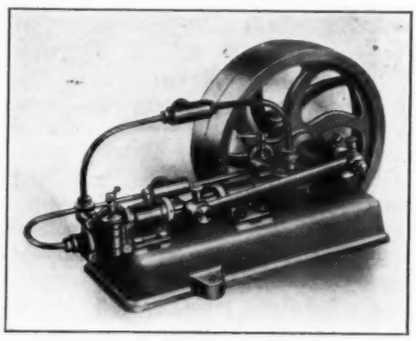


FIG. 19. DOUBLE-ACTING HYDRAULIC PRESSURE PUMP.

little of it at that, is apt to be more sensitive in this way.

There is plenty of gold yet to be mined, though the wasteful methods of our forefathers can no longer be followed with profit, and their very wastefulness, unconscious as it may have been, furnishes a new opportunity to those who come after them. The man who imagines because Stanley let daylight shine into the last undiscovered corner of "Darkest Africa," or because great engineers have admitted the reciprocating steam engine has been brought about as near perfection as we can expect, that there is nothing left for him to do, is likely to wake up and find himself left way behind. Some of his old shopmates will then be supplying Africa with electric lights from the mighty cataracts of the Nile, while others will be building steam turbines and gas engines of an efficiency yet hardly hoped for.

Just so long as there remain imperfections there will be no lack of things to think about, to find out, and of things well worth our while to do our level best over. Which is equal to saying there will be small lack of opportunity while the

world endures. *But* "The Lord don't send no derricks 'round to hist folks out of ruts!" Remember that.

My skepticism regarding the comparative goodness of old times began when I was a very small boy indeed—a boy much fascinated with anything pertaining to a locomotive, and whose youthful soul was filled with wrath and disgust at having to listen silently to his aged grandfather railing at "the damned cars that were nawthin' but a cuss to the country." Not till I was older did I learn that his bitterness arose from the fact that before their advent he had made good money hauling country produce to Boston with horses. And if he was not too narrow to realize it, he was too stubborn to admit that in taking away his most profitable employment the iron horse had brought benefits untold to thousands and millions. He seemed determined to squelch my mechanical instincts, and possibly the persistent way in which I thwarted him by clinging to them harder than ever may have caused me to take it up as a life work. At any rate, I do not cherish an uncharitable memory of the old man. He often told me candidly that I would never amount to much, and I surely didn't at the work he set me to do; but he lived to marvel at the fact that "the boy" was getting real money in satisfactory quantities just by making pencil marks on a sheet of paper. And I was satisfied with this revenge.

Poor short-sighted old chap. There are plenty of them still with us who think old ways the only good ones, but that sort of thinking and talking is generally conspicuous by its absence among those who have much to do with machinery. Today six copper wires carry thousands of electrical horse-power across the little farm where he was contented to toil, and uncounted automobiles go honking and whizzing past the rural cemetery where his bones repose. He died in time to escape these more recent "cusses to the country." He was in a rut, that was about all the trouble, and I don't know that I can give a better finish to this than once more to repeat: "The Lord don't send no derricks 'round to hist folks out of ruts."

The Empire Machine Company, 210 Third avenue, Pittsburg, Penn., issue a little pamphlet describing their tachometer, which we have published an illustrated account of, and in this pamphlet they give a number of causes for irregular speed of steam engines, which are interesting and to many will be instructive, regardless of the matter of the tachometer.

Those who would rather save the price than spend it for a superior field glass ought to carefully avoid reading a small pamphlet recently sent out by Warner & Swasey, of Cleveland, which describes such an instrument and some of the uses to which it can be put. "Reflections of a Rambler" is very captivating.

Foreign Markets for American Machinery.

It would be well for American exporters of machinery to note that the new tariff of the South African Colonies gives an increased preference to the United Kingdom. It came into effect on July 1, 1906. The object of the revision is to encourage the purchase of manufactures from British and not from foreign markets.

Class IV gives a long list of items on which 3 per cent. ad valorem is levied, but the whole of this duty is remitted where the goods come from the United Kingdom or reciprocating British Colonies. This class includes machinery and engineering requisites, bands and belting, steam packing, wire rope, boiler composition and boiler tubes, bolting cloth and mill silk, cloth gauze, matting, sieving and screening for mining purposes, bolts, nuts, rivets, washers, nails, screws and similar wares. haulage chains, cranes, elevators and shears, crucibles, fire extinguishing appliances, tanks, railroad sleepers. All goods not otherwise charged with duty and on the free list, will have to pay 15 per cent. ad valorem rates, with a rebate on British goods of 3 per cent. There are very few lines now left on the free list. The new duties will considerably affect the United States and Germany, although the latter country is partly compensated by its Government railway and steamship subsidies. The ultimate idea is to shut out as far as possible all non-British goods, and this new tariff is the first step in that direction. It is open to the United States to join in the reciprocity scheme, reducing its duties on British manufactures and on British Colonial produce, and to receive in return most favored Colonial treatment throughout the Empire. Of course the United States exporter to South Africa has an enormous advantage at present in the cheap freights he secures, being, roughly, 25 to 50 per cent. less than freight from British ports. America has also a great hold on the machinery trade of the Colonies, especially the mining section of the Rand. This is due to the amount of United States capital invested in the mines which enables influence to be asserted in the disposal of the order, and the large number of American engineers employed in the industry. These naturally prefer the machinery and plant of the United States, with which they are familiar, to those of the United Kingdom, with the necessary result that the orders go to Americans. Similar tendencies resulted from the early settlement of foreign engineering and merchant firms in Johannesburg, and in certain of the coast towns. Similar results will appear in Rhodesia, as that colony offers capital chances to any enterprising American firm of engineers, who would do well if they pursue common-sense lines regarding local conditions of trade, etc.

It would repay American firms to look after the East Indian trade. Manufacturers of bridge work, railroad permanent way material, and railroad stock may look for a large volume of indents as the result of the Government's extensive plans. The bridges required will be of the girder type and will cost at least Rs. 172,000 each. Among contracts recently placed with home firms is one for 40 swan bridges of about 60 feet span for the East Indian Railroad. This follows an order for 170 bridges of 40 feet span each for the Northwestern railroad of India. The East Indian railroad is to invite tenders for the steel work for the Jumna bridge, Allahabad, the main span being 160 feet and the land span 40 feet. The Madras Government will be wanting rolled steam beams and other girder bridge requisites. The East Indian railroad is going to expend at least a lakh of rupees on the provision of 595 cow catchers for its engine rolling stock. Additional rolling stock is to be provided for the Eastern Bengal Sindh railroad at a cost of Rs. 876,000, and including 150 bogie iron covered goods wagons, etc. There are also several important hydro-electric schemes on hand. The price of electric power is estimated at half that of steam power. The chief project, for which a company with £2,000,000 capital has been formed, is the construction of a hydro-electric power installation in Kashmir, by harnessing Whelan river. It will alter the face of the whole district, and convert Kashmir into the Lancashire of India. This scheme alone offers valuable opportunities to American suppliers of electrical machinery and plant. The use, too, of constructional iron in India is enormously increasing, the over-sea imports alone of corrugated iron totalling over £6,000,000. There is an immense amount of iron frame building work going on throughout the country. It is found that such buildings, if properly constructed, are the best for tropical storms, the iron roof serving to collect the dangerous fluid, and the iron pillars and other uprights acting as safe conducts of it to the earth. There is a splendid opening for all sorts of the elemental items of construction, including wire-woven roofing, armored concrete, etc.

A careful study of German economic and trade conditions in the engineering and hardware industries shows that the German exporters will have a more difficult task than has hitherto been the case, to hold their iron in foreign markets. This will arise from the steady increase in the cost of production. The German operatives are keenly alive to the idea of improving their social condition, and the many strikes of late years have revealed their power to them. At the same time the German competition will be no less to hold their iron in foreign markets. This success of their goods abroad cannot be explained by reason of relatively low wages (which are steadily rising now)

and unfair practice, such as imitation of trade marks, etc. Wages have increased considerably, and exports have grown all the time. Nor is it only the inferior article that swells the export figures, for the exportation of better class and expensive high-class articles is increasing to a remarkable extent. It is clear that German manufacturers will have to face increased duties in one of the most important foreign markets. But Germany has attained now a high standard of efficiency; she has first class engineers and chemists, careful adaptation to the wants of foreign markets, coupled with splendid skill of her operatives.

London, Eng. F. C. C.

Large Induction Motors.

A lot of four induction motors, the largest yet installed west of the Mississippi river, has recently been supplied by the Allis-Chalmers Company to the Washoe smelter of the Anaconda Copper Mining Company, at Anaconda, Mont. Each motor has an output of 1200 h.p. at a synchronous speed of 360 revolutions per minute, and operates on 60 cycles three-phase current at a potential of 2080 volts. The circumstances leading to the construction of these large motors were briefly as follows:

The Washoe smelter has an output of copper of from 15,000,000 to 17,000,000 pounds per month. The power was formerly all supplied by steam engines, and it is probable that a certain amount of steam power will always be used, as some of the steam boilers utilize the heat contained in the waste gases from the furnaces. This power, however, is nothing like sufficient to operate the whole plant, so in the future all additional power is to be supplied by electricity, and the plant has been equipped throughout with electrical drive. The electrical transmission line for this purpose is of itself quite remarkable. The power is developed on the Missouri river near Helena, nearly 100 miles away, the river having been dammed so as to form a lake near the capital city. The transmission will be at an electrical pressure of 70,000 volts over a double line to Anaconda, where will be located step-down transformers to reduce the pressure to 2200 volts.

The four large new motors will be used for driving the concentrating plant, which is the first unit to be driven exclusively by electric power. This building, which is 600 feet long, has in its center a steam plant, which will be retained in order to provide for emergencies, but the shaft on each side of it will be disconnected, and on each side of the mill will be placed two of the motors, which will drive the main shaft by rope drives and friction-clutch pulleys.

Besides the large size of the motors, a notable feature is the fact that they have squirrel-cage rotors, which is unusual in such large motors. Their guaranteed full-load efficiency is 91 per cent., and the full-load power factor is 92 per cent. Squirrel-cage rotors were chosen for the installation because the conditions under which they have to start are favorable, and also because of the higher power factor of this kind of motor, as compared with the wound-rotor type.

The general construction of these large induction motors is practically the same as that of the smaller ones built by the Allis-Chalmers Company. The stator punchings are supported in a substantial yoke to which the housings carrying the bearings are bolted. The bearings are adjustable to permit compensation for wear, and thus maintain a uniform air gap between stator and rotor. The stator is wound with copper strip, with the slot insulation formed around it under pressure in steam-heated molds. The end connections of the winding are rigidly supported to prevent any distortion due to abnormally large current. The rotor is mounted on a spider provided with cast-steel end rings, between which the laminations are held. The rotor slots are of the partially-closed type, and the rotor bars are securely held in place by the overhanging tips of the teeth. The bars are bolted at each end to bronze short-circuited rings, thus making a very strong rotor that can be safely run at high peripheral speed. The motors will be started by means of an oil-immersed controller connected to an auto-transformer, which lowers the applied electromotive force at starting. The machines were built at the Cincinnati works of the Allis-Chalmers Company.

Tantalum, one of the hardest of metals, is made into sheets and bars by means of a "squirting" process, by the Siemens-Halske Company. Water and gum tragacanth are mixed with tantalum powder, and then forced into rods, etc.

Experimental Technology of Deformation of Materials, and Its Application to Metal-Working Processes—III.

BY H. I. HANNOVER.

SECTION II—EXPERIMENTS ON DEFORMATION BY TENSION AND THEIR PRACTICAL APPLICATION.

A. EXPERIMENTS AND THEORY.

By a reflection similar to that which is made by Kick on compression (Fig. 1) it is to be found how the action on the single molecules in a cylindrical body will be, when this is subjected to a tension applied at its ends, as shown in Fig. 21, presuming for the present that the tension is distributed uniformly over the terminal faces and acting only on these. Brittle bodies, as for instance cast iron, break right through when the force has increased so much that the cohesion between the molecules, which in such bodies is smaller than the inner friction between the molecules, is overcome.

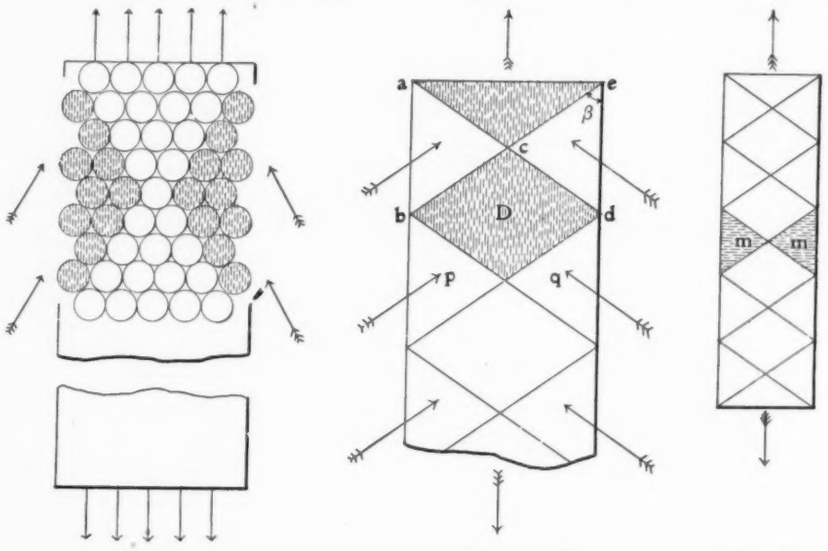


FIG. 21 FIG. 22 FIG. 23

DIAGRAMS ILLUSTRATING THE DEFORMATION OF A CYLINDRICAL BODY UNDER TENSION.

With tough bodies, as for instance wrought iron, the cohesion is, on the contrary, larger than this friction, and for this reason there will, before the rupture occurs, arise a deformation, that is, when the external force at the so-called yield-point overcomes the named inner friction. The particles inside a cone—the sliding cone—which is shown more plainly in Fig. 22, *a c e*, will then move in the direction of tension, while the particles outside this part of the body—shown hatched in Fig. 21—will move obliquely in toward the sliding cone, as indicated in Fig. 22 by the oblique arrows on *a b c* and *c d e*.

Now Professor Reitoe in Budapest* is of the opinion—because of the reason hereafter mentioned—that hereby the in-

*Reitoe: "Die innere Reibung der festen Koerper." Leipzig, 1897.

ner friction between the molecules in the part of the body hitherto regarded increases, i.e., the molecules inside the part *a b c d e a* of the body have been squeezed more tightly together than before.* Although, as appears from the most recent microscopical experiments, it hardly is the friction between the molecules which is overcome, but perhaps rather the friction on the sliding faces of the single crystals, and although it is consequently this friction which increases—whereabout more will be stated in Section VI—we will, however, here proceed with the views of Mr. Reitoe. The further deformation will then for the present not occur inside this part of the body, but inside the following part, where the molecules are not yet squeezed so tightly together, and where they may for this reason more easily slide on each other. Regarding this next part of the cylinder we must in that case suppose that it is subjected to a tension along the conical surface *b c d*, Fig. 22; and if again Mr. Kick's views are carried out, we will find that of the part examined at present the double cone *D* will move in the direction of tension, while the ring marked with the arrows *p* and *q* will close up against *D*, just as previously the ring *a b c d e c* moved in toward the cone *a c e*, and then there will in the parts of the body now considered arise the same larger friction as before in the part *a b c d e c*. Then the deformation will assail the next part of the body, and so on.

Suppose, now, that the deformations in like manner advance from the other end of the body. The consequence hereof will be that, for instance, the part which, owing to the pull in the upper end of the cylinder, tended to move in the direction of the arrows *p* and *q*, Fig. 22, in reality rather may be supposed to move in a somewhat other direction, namely, a little more horizontally; so that, if the pull is produced by making the ends of the body move away from each other, the middle part *m*, Fig. 23, will at any rate move inward, as indicated by the hatching.†

Here we have, for simplicity's sake, assumed that the cylinder lengthways may be divided just into a certain whole number of parts, as for instance *m*, Fig. 23, the length of which correspond to the total hight of the double cone *D* in Fig. 22; because otherwise the conditions at the middle of the body will be somewhat more complex. This we will, however, not investigate more closely.

*Strangely enough Professor Grunmach, in Berlin, has, however, not been able to find any increase in specific gravity on that account.

†Kirsch has found, by measuring the contraction of a bar during extension, that the contraction could be traced first at the ends and then gradually farther in toward the middle, see: "Mittheilungen aus den kgl. Versuchsanstalten zu Berlin," 1887, p. 74; but according to experiments made by Kurrein, "Baumaterialienkunde," 1904, pp. 196 and 233—the deformations begin at one end of the bar and then extend to the other end, and in that case the last views set forth above are of course not applicable.

THE "ANGLE OF ACTION" FOR TENSION.

As will be discussed later—in Section V—it may be considered proved by experiments that in tough bodies, when subjected to tension, there really arise slidings along conical surfaces, as here supposed, and the angle β between the generatrices in these sliding cones and the direction of pull proves to be equal to the angle β in Fig. 2, when it is the same material; or, it appears that *the angle of action β always ought to be measured as the angle between the direction of sliding and the direction along which the dimensions of the body increase.*

In the above we have all along assumed that the cylinder which is subjected to tension is attacked by the force in the terminal faces, which, however, is seldom the case, since a body generally is stretched otherwise—for instance by the pulling shackles gripping around the ends. In that case the slidings do not take place along a single series of sliding cones, as shown in Fig. 22, but along a large number of such, which consequently lie inserted one into another.

Likewise we have in the above entirely thought of cylindrical bodies subjected to tension. If we now, on the contrary, examine the conditions in a bar with a rectangular cross section, we find that in this the slidings take place at the same angle with the external force, whether we regard the bar from the broad or the narrow faces.

Consequently, in such a bar under tension sliding takes place in the direction of four different planes.

THE INCREASE OF THE INTERNAL FRICTION.

When now the deformation—as explained above—gradually has advanced from the ends of the body to the middle, whereby, as mentioned, the inner friction simultaneously is increased everywhere in the body, no further deformation can take place, *before we increase the pull*, which also appears practically to be the case. But when the force is increased it will once more be able to overcome the inner friction in the ends of the body, and the whole previously mentioned process repeats itself; *hereby the inner friction increases again* throughout the whole body, so that the pull again must be increased to produce further deformations.

It was no doubt this fact, known from experiments on tension with metals—namely, that we must increase the force to make the deformation advance gradually—which led Mr. Reitoe to the thought that the inner friction must increase with the continual extension.

Originally Mr. Reitoe stated that the process would go on in the manner just described, until the *absolute maximum* of inner friction was reached—that is, the maximum which, on the whole, can be obtained in the material owing to deformation; but later he has, in a lecture delivered at the international congress for testing materials in Paris, 1900, reported that such a maximum cannot be obtained at all by tension, but only by compression. When, however, the inner friction has increased as much as is possible by tension, a tough body will begin to contract at a single point, and it breaks as a rule here. Consequently, the deformation appears in this period to assail the body only at this point. Mr. Reitoe says that now the body is no longer *tough* but *plastic*, as for instance clay, which, when subjected to a pull, immediately contracts at a single point. Mr. Reitoe distinguishes consequently between tough and plastic materials. In both the inner friction is overcome, so that sliding takes place before the rupture occurs on account of the overcoming of the cohesion; on the contrary, in a brittle body, as for instance cast iron, the cohesion is, as mentioned above, from the beginning smaller than the inner friction, so that rupture here occurs without perceptible deformation.

It would lead too far here to consider the conditions during the contraction, especially as they hardly will be of any interest in the industrial applications of deformation. As to the surfaces of rupture, they exhibit usually parts of sliding faces—in the case of round bars, sliding cones—but in brittle bodies, as hardened steel and cast iron, the rupture occurs at any rate chiefly after the straight system, i.e., right across. (See Section IA.)

B. APPLICATION TO THE PROCESS OF WIRE-DRAWING AND ANNEALING.

Mr. Reitoe understands by the term toughness that work of inner friction which for every cubic centimeter of the body must be overcome before the deformation makes the inner friction increase to maximum. From this explanation it follows directly *that the stretching of a tough material reduces its toughness*, and from the explanation it may easily be understood why cold mechanical treatment diminishes the toughness, or, what comes to the same, increases the brittleness.

These treatments — for instance *wire drawing*, which in reality is a stretching, and further also *cold rolling*, which is a pressing—increase the inner friction, so that the work in deformation required for obtaining maximum of inner friction is smaller. If a material which has been subjected to such cold treatment is annealed, the heat will expand the molecules which are squeezed tightly together, and it is an obvious conclusion that they push each other away, and that at the succeeding cooling they do not quite leave the position attained where they are less tightly squeezed together; that is to say, they lie in such a manner that the inner friction is a minimum, i.e., the toughness is as great as possible.* In effect, the circumstances

*We may here also call to mind that Mr. Reitoe measures the hardness by means of the inner friction.

are more complex, as it will appear in Section VI B.

Regarding other metals than iron and steel André le Chatelier has shown that when owing to cold treatment they have become harder and stiffer, they get annealed "spontaneously," as it might be termed—that is, they regain toughness also at ordinary temperature, only it takes a much longer time. Thus a copper wire may be drawn out indefinitely without requiring real annealing between the drawings, if only the intervals between these are long enough.

About Lüders lines, which under certain conditions appear on the surfaces of bodies subjected to tension, there will be given information in the sequel (see Section V) from which it will be seen how they in a fair way prove the theory of Mr. Reitoe.

Besides, Mr. Reitoe has carried his theory further on to explain the deformations by compression, shearing, punching, etc.; but it would lead us too far to discuss this question. We will in the following section, in a simpler way, render an account of what happens by these processes.

(To be continued.)

Our assured manufactured sheet brass and copper. They use petroleum oil to anneal this at the furnaces. A receiving tank is placed near the railroad running to the works. An underground pipe leads from this to a pit which is 3 feet wide, 6 feet long and 12 feet deep. From this pit other pipes go to other tanks. These other tanks were being repaired. The receiving tank was being filled.

An employee noticed that the valve in the pit was turned the wrong way and that oil was flowing into the pit, and from it to the secondary receiving tanks. He at once got into the pit to turn off the flow of the oil. He was overcome by the fumes and suffocated to death. A second man, seeing his predicament, jumped down to pull him out. He also was suffocated. A third man exclaimed, "Well, those two are married and I'm not!" and jumped in to save them. He suffered the same fate as the other two. A fourth man then had a rope put about his body and jumped into the pit to rescue those already there. He was unsuccessful in doing this, and was himself dragged from the pit in such condition that he spent some two weeks or more in the hospital.

This story is printed to indicate the rare and admirable devotion often exhibited by laboring men when their comrades are in danger or suffering. The helpfulness and charity rendered by them is more creditable than the benefactions of the rich. The rich give of their abundance; the poor cast in all that they have, even all their living. —*Monthly Bulletin of the Fidelity and Casualty Company.*

Letters to the Editor.

Boring Bar Cutters—Sectional Dies.

The style of fastening shown at Fig. 1, page 677, Vol. 29, Part 1, I consider good for a vertical bar when there is room for the chips to fall out through the cored hole below the cutter. A special advantage of this form of fastening not mentioned by U. B. S. being that the nut may serve as a bushing to fit the bored hole in cases where a long hole must be bored by a light springy bar. This form of fastening used on a horizontal bar needs plenty of clearance around the nut to let chips out.

Personally I am opposed to a round pin for centering a cutter and think a collar on the back of the cutter fitting into

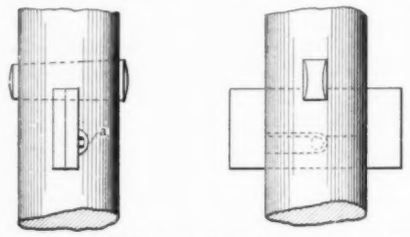


FIG. 1. CENTERING AND HOLDING THE CUTTER WITH A WEDGE.

grooves cut in it would be found preferable.

The common style of cutter and bar shown at page 812, Vol. 29, Part 1, has some objections that have not been mentioned by your correspondents.

Even after such cutters are carefully fitted up, the hardening may so change them either by shrinking or expanding that they will either be too tight or too loose in the bar. When the cutter is short

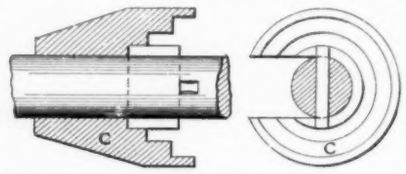


FIG. 2. THE GAGE FOR CENTERING THE PLAIN CUTTER.

in proportion to the size of the bar the cutting lips are very apt to crack in hardening, so that they give little or no service, and at best give small return for the work expended in fitting up, as the sharpening soon cuts off the projections which center the cutter in the bar, and the sharp edge resulting from the grinding will chafe the seat in the bar unless very carefully handled.

As stated by U. B. S. the key on the back of this form of cutter as shown at page 812 is apt to spring the bar when carefully fitted, and when, as often happens, the original key gets lost and a make-shift key is put in, the spring of the bar is a certainty.

I believe, however, that a wedge is the ideal form of fastening for such cutters, and suggest the style of application shown in the accompanying sketches, Figs. 1 and 2.

As will be seen, the key serves both to locate the cutter and to clamp it in place with practically no tendency to spring the bar. The key should be a close fit sidewise both in the slot and in the cutter and should be wide enough at the small end so that it will not go to place except through the notch in the cutter.

A small groove *a* is cut on one side of the cutter slot, extending part way through the bar, and a small pin in the cutter sliding freely in this slot insures that the cutter will be put in but one way. A similar groove may be cut in the key-way and a screw in the key will prevent the latter from being removed entirely from the bar in changing cutters.

Under certain conditions cutters need not have any centering notch whatever, the key fitting against the plain edge of the cutter, and the latter centered in the bar by a gage shown at Fig. 2. This having the advantage that a cutter can be made to vary the size of hole by setting it out of center.

This gage *C* may be a collar fitting closely on the bar with one side cut out so that it may be removed sidewise, and having any convenient number of sizes bored in it as shown.

Many variations of this will suggest themselves to those who have work that it will suit.

A word as to the grinding of boring cutters. I find it is almost universal practice to bevel the cutting edge to about the angle of a twist drill, or even more acutely, the tendency to do this being increased by the desire to get as much work out of the common lipped style of cutter as possible and yet preserve the centering lips.

I believe that this style of grinding is a mistake as it increases the width of chip for a given cut, and a cutter so ground tends to follow the original hole much more readily than one ground at right angles with the bar, exactly as a counterbore is ground, the corners only being slightly rounded.

Several sectional dies have been shown in your pages recently and I would like to ask if anyone has used such dies on unannealed spring and tool-steel stock.

This dulls the cutting edges of punches and dies very quickly and I would expect that the tendency of the blanks to "plug" in the die would cause the joint to open. I have been able to use a cracked die by keeping it sharp, but a little dullness causes the crack to open.

One sectional die is shown with the halves held together by set screws. It seems to me that a wedge with plenty of metal behind and under it would be far preferable as the jar of a press will be very apt to loosen a set screw.

The common practice, I believe, in fitting a wedge, is to plane the die seat tapering for the key, the die sides being

parallel. This necessitates planing one side of the die seat and then shifting the die bed around to obtain the taper. The die seat may be planed at one setting by using a key on each side of the die driven from opposite ends. This also has the advantage of giving a minute amount of adjustment both ways in setting dies.

W. L. HARDY.

Broaching Brass Rings.

Figs. 1 and 2 show adjustable broaches as used in a vertical broaching machine for finishing the internal faces in turbine rings, Fig. 3, which are a part of the Crown water meters of the sizes which register the amount of flow in pipe lines of ¾-, 1-, 1½- and 2-inch diameter, respectively. The rings are made of cast brass, of the variety known as plumbers' metal. Previous to the broaching operation they are faced, bored and turned to fit gray-iron rings like Fig. 4, which hold them during the operation in the broaching machine.

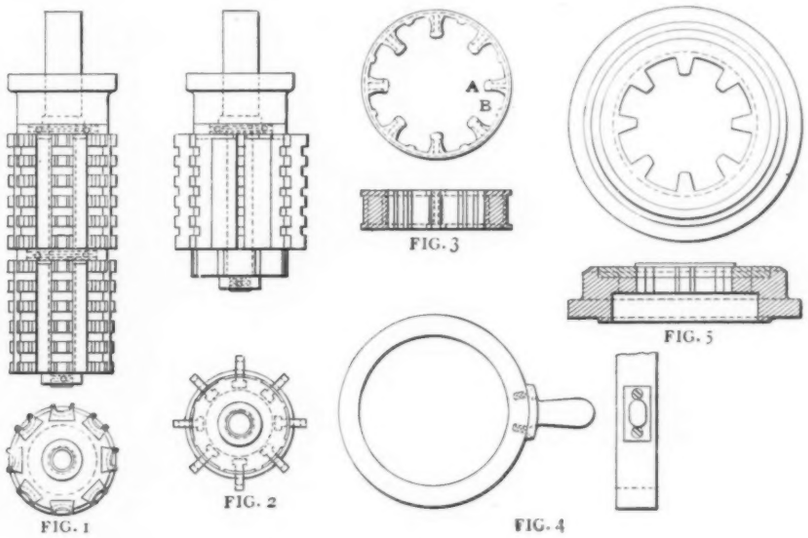


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5

BROACHING BRASS RINGS.

The boring removes only a small portion of the surplus stock from the innermost points, the main object of the operation being to create true contact surfaces for the expanding chuck, which holds them for turning the outside diameter and for facing the second side. The stock removed by the broaches varies from 1/32 to 1/16 inch in depth in perfect castings.

The broach, Fig. 1, is used in the first broaching operation and finishes the faces *A A A*. It is made in two sections, because of the difficulty in keeping long cutters of this shape straight during the process of hardening and tempering. The body pieces are made of gray iron and contain inclined dovetailed grooves for holding the cutters to permit of adjusting them to the proper dimensions after sharpening. The upper ends of the body pieces are threaded for the abutment nuts for the cutters. These nuts cannot be properly called adjusting nuts, because owing to the necessary tight fit and number of the cutters, adjustment is impossible with the aid of them, the adjustment being attained by first driving the cutters down, then turning the nuts the required fraction of a revolution, and then forcing the cutters back against them. The cutters are formed with a relief of 0.020 per inch. The first circle of teeth in the lower section is 3/32 inch smaller in diameter on the rounded faces than the last two circles of finishing teeth on the upper section. The diameters of the teeth on the lower section are arranged so that each tooth takes off 0.006 of stock, the amount diminishing with the circles of teeth on the upper section, so that each tooth on the first circle of the two finishers will shave off only 0.001 inch. The projecting parts of the cutters which finish the angular faces are stepped for gradual cutting to prevent breakage in case of irregularity in some of the castings.

The broach, Fig. 2, is used in the second broaching operation and finishes the faces *B*. The body is made of gray iron and contains inclined T-slots for holding the cutters. Each of the teeth in this broach, with the exception of those in the two upper circles, takes a cut 0.010 inch deep, and in irregular castings those of the first circle sometimes take a cut 1/16 inch deep. The broach is guided by a pilot made of gray iron fitted to the rounded points finished in the first operation. The arbors for the broaches are of tool steel for stiffness and are splined and keyed. The butts are made of gray iron and are driven down to a shoulder on the arbors. The broaching base, Fig. 5, is gray iron and has a tool-steel plate inserted at the top for a working surface, the inner edge clearing the broaches by 0.010 inch. Three projections form a recess for centering the holders containing the rings to be broached, and on the under side is a shoulder for centering the base in the broaching machine. Two operators are kept busy during the broaching operation, one inserting the rough rings into the holders and taking the finished rings out in a ball-weighted lever press, and the other feeding the broaching machine. After the broaches have passed through the rings the holders are turned the required amount to allow the cutters to back out between the finished points. For rings for ⅜- and ⅝-inch meters the three broaches, having bodies made of machinery steel, are placed on one arbor, the broaches as shown in Fig. 1 being placed one below and one above that as shown in Fig. 2, and after passing through a ring the nut on the end of the arbor is unscrewed and the broaches are stripped off the arbor. The machine is then reversed and the ram is brought back to the starting point, where the broaches are again put on the arbor and started on their way through the next ring to be finished.

The broaches leave highly finished surfaces in the rings, they having the appearance of being burnished. The variation in size is within 0.0005 inch of the required dimensions.

H. E. R. MANBRAND.

The Demand for Graduates.

I was much interested by what was said at page 126 concerning the demand for graduates, as I have met many people who hold the opinion that there is not much difference between a college diploma and a small gold mine. Not long ago a young friend of mine graduated (or was graduated, as the calendars have it) from a first-class university as a mechanical engineer. Previous to his course he had served his time in a good machine shop for machinist and tool-maker, and every summer he worked at the trade in different places. Near the end of his fourth college year he received several letters from firms offering him positions. In substance they were about like this:

Dear Sir: We are informed that you will be open for a position about June or July. We find we have room for a young man, with every opportunity for rapid advancement to the right party. The salary in connection with said position will at first be more nominal than otherwise. Awaiting further advices, we remain, yours very sincerely,

The Ever Ready Mfg. Co.

My friend wrote to two of these concerns, and inquired the nature of the duties expected, and the amount of remuneration. One concern thought $8 per week for someone to do its testing and a lot of incidental bookkeeping was sufficient for a start. The other was more generous and offered $10 for a young man who, as far as could be gathered from the letter, was expected to do all the odd jobs from the drafting room to the sales department. After perusing these letters carefully, the young man wrote and asked them what they paid their tool-

makers, and sent letters of reference, telling them he was a first-class specimen, and that he would rather consider a proposition with this fact as a basis. Neither of the firms replied, doubtless securing what they were after by getting someone less fortunate in having obtained practical training. The inquiries were written by my friend merely for general information, as his position was before him previous to his entering college. However, if they serve to enlighten any prospective students as to the condition of affairs, they will not have been wasted.

NERALCM.

An Ink-Retainer for a Pen.

I have been using the attachment shown on my pens for some time, and find it just the thing when putting the figures on a drawing.

It consists of a small piece of thin sheet

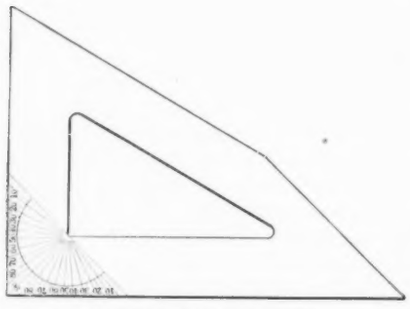
AN INK RETAINER FOR A PEN.

copper, bent as shown, and inserted in the pen holder it acts as a retainer for the ink.

In this manner many more figures or letters can be put on a drawing with fewer fillings of the pen. J. K. C.

A Combination Triangle.

I have been using a triangle similar to the one shown in the sketch for some months and find it to be one of the handiest tools I ever had on my drawing board.



COMBINATION TRIANGLE.

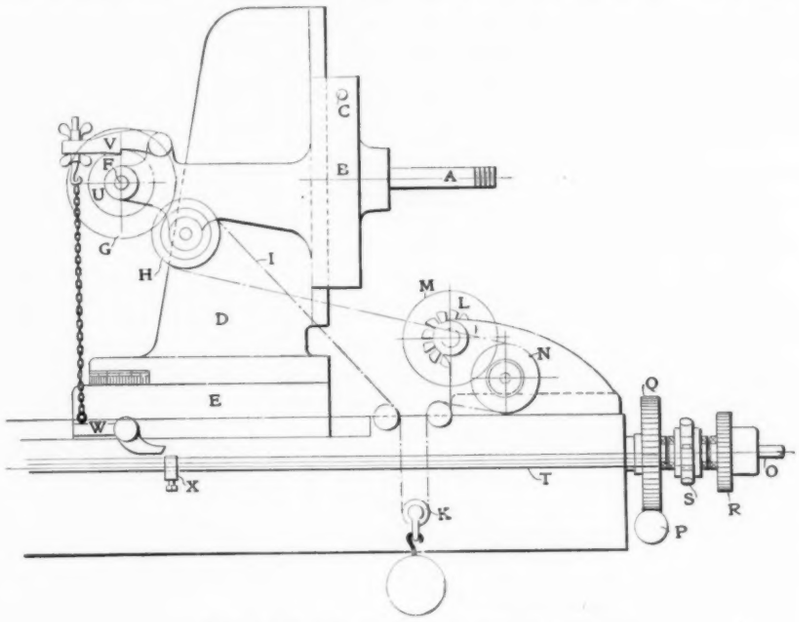
The one I have I made from a 14-inch, 60- and 30-degree transparent-celluloid triangle by cutting the 30-degree point to an angle of 45 degrees.

The protractor shown across the corner of the 90-degree angle I made by using a standard protractor to lay off the graduations from, then scratching them into the celluloid with a very sharp pointed scriber, and numbering them by tens of degrees as shown on the sketch.

While these graduations may not be laid out with any great degree of exactness, they will in most cases answer all the requirements of the ordinary draftsman. E. W. BOWEN.

Knock-Off for Automatic Gear-Cutter Feed.

The drawing inclosed shows as much of one of our automatic gear cutters as is necessary for the illustration of this article. This machine had to do all our gear cutting for three or four years, till we got our Brown & Sharpe machine; then we began to find fault with it. *A* is the work arbor (which has no support for the cutter end), *B* is the box which carries and covers the dividing wheel, the worm shaft for operating which is shown at *C*. The worm-gear case is moved up and down on standard *D* by means of a hand



KNOCK-OFF FOR AUTOMATIC GEAR-CUTTER FEED.

wheel and screw, which is provided with a graduated dial but no visible means of support for a zero mark, so that when setting to depth it is necessary to hold a rule or straight-edge up with one hand and turn the hand wheel with the other; not a nice job by any means, taking into consideration the fact that the hand wheel is nearly six feet from the ground. Standard *D* (which has a graduated base and is secured to slide *E* by three bolts in a circular T-slot) swivels so that straight-face worm wheels may be cut. *F* is the one-revolution or locking-disk shaft common to most gear cutters; it is driven through the gears *G* and *H* by the round leather belt *I*, which is driven from the main shaft of the machine, a weighted tension pulley *K* compensating for the feed and return motions. The cutter is shown at *L*; it is driven through spur gears *M* and *N* by a four-step cone. *O* is the feed screw which is driven, when cutting, by worm and worm wheel *P* and *Q*; and, when returning, by gear *R*, both motions being transmitted to the feed screw by a clutch. The clutch lever is shown at *S* and the rod by which it is operated at *T*. The dividing gear has 60 teeth, so that when cutting a 12-tooth gear it is necessary that the worm shaft *C* make five revolutions to one of the locking-disk shaft *F*; this it did sometimes. When nobody was looking, of course it didn't—with the result that our scrap heap received another contribution. This occurred much oftener than we liked; so we designed the safety motion. On the locking-disk shaft *F* was mounted a disk *U*, into which had been milled a notch. A lever *V* was mounted so as to ride on the periphery of the disk, this lever being formed with a projection of approximately the same shape as the notch. Attached to the lever is a chain which is fixed at the opposite end to another lever *W* mounted on and moving with slide *E*.

The operation is as follows: The machine, having cut a space, returns, and at the end of the return stroke sets in motion the one-revolution or locking-disk shaft *F* and with it the disk *U*, which, as it revolves, lifts lever *V* and keeps it up till the notch comes to the top again, when the lever drops down. Now suppose the locking-disk shaft sticks after making half a revolution; lever *V* is held up and by means of the chain moves lever *W* till the right-hand end is in line with collar *X* (which has previously been adjusted at the same time as the stroke). The machine goes on feeding till lever *W* pushes the feed clutch out of mesh by means of collar *X*, rod *T* and clutch lever *S*. It will be seen that this device must be adjusted for different wheels, but at the same time we couldn't think of a better method of doing the job; and I don't know yet how it would be possible to make so efficient and cheap a job any other way. The only parts required were

the levers *V* and *W* with their studs, the chain with its connections, disk *U* and collar *X*.

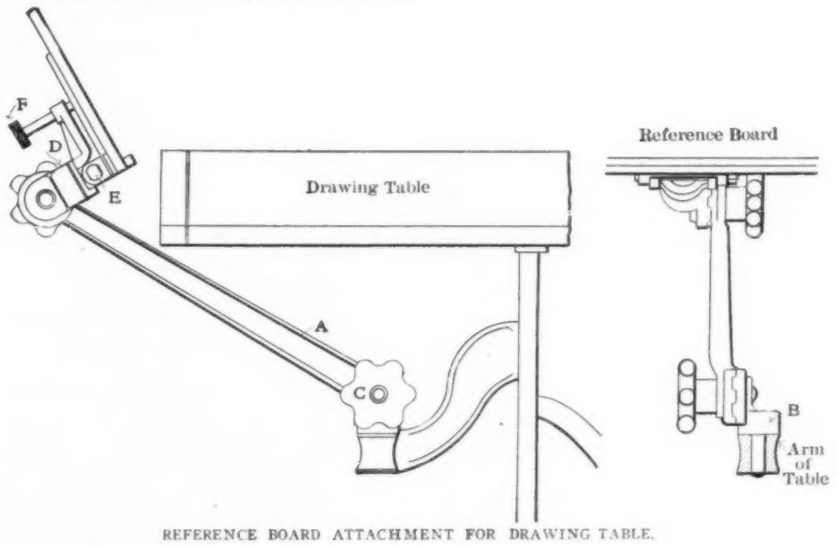
It was necessary to use a chain on account of the swiveling motion of column *D*.

This attachment has paid for itself many a time over, but at the same time it is possible to make spoiled gear blanks, as I once found to my cost while working a machine which had what might practically be called a positive indexing motion; at any rate, there was no safety device, and if there had been it wouldn't have helped. I was cutting a quantity of 45-tooth five-pitch gears, five at a time, and had no trouble till I came to the last batch, when, after cutting about half-way around, I happened to glance at the machine and found that it had cut a space where there ought to have been a tooth; and after skirmishing around for a bit, I found that the change-gear plate for the indexing motion had slipped around (the bolts must have worked loose) till the change gears were out of mesh, so that no safety motion (that I know of) would have saved the situation and the blanks, as the locking disk was going on doing its work honestly and as regularly as a clock.

H., England. G. EAR.

Attaching a Reference Board to the Drawing Table.

I inclose herewith the sketch of a fixture designed to support a light reference board to be used in conjunction with the ordinary commercial drafting tables, having an iron bracket for supporting a cabinet or tray by means of a swinging arm. *A* is a swinging arm attached to the pivot *B* by a serrated joint and locked at the desired angle by the hand nut *C*. The upper end has a similar joint by which it is attached to a socket, in which is pivoted the bracket *D* attached to the reference board. This bracket is fitted with a joint at *E*, allowing the board to be adjusted to the desired angle by means of the screw *F*. It will be seen that by this arrangement the board may be placed in almost any position or angle desired. S. B.



REFERENCE BOARD ATTACHMENT FOR DRAWING TABLE.

The Closing Angle of an Irregular Figure.

In any irregular outline, such as the one shown in Fig. 1, the unknown angle may be found as follows:

$X = 180(n - 2) - S = 180(5 - 2) - (120 + 90 + 60 + 110) = 160°$.

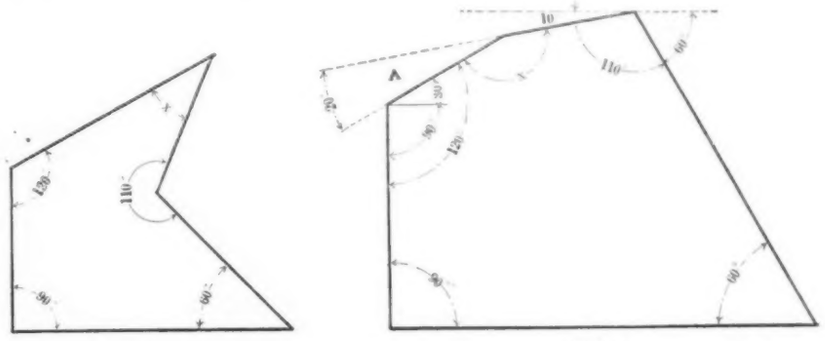
Where N = number of angles.

S = sum of known interior angles.

There is nothing new in this, but the method is not as well known among draftsmen as it might be. When all the angles are given, this is a ready means of checking the correctness of their sum, and it is easy of application even when the figure is composed of a great number of sides.

Many draftsmen proceed to find the remaining angle in the manner shown in Fig. 2 by a process of addition and subtraction with reference to one side chosen as a base line. The angle *A* is obviously the difference between 30 and 10 degrees, or 20 degrees; and *X* is found by subtracting 20 degrees from 180 degrees. This method requires that the sketch be properly drawn in order that the bearing of the sides may be taken correctly. Fig. 1 is purposely drawn incorrectly. The angles given are the same as those of Fig. 2, *X* being shown as an acute angle, while the result proves it to be 160 degrees, and the angle given as 110 degrees is drawn as though considerably more than 180 degrees. This does not in any way affect the application of the formula.

GERALD E. FLANAGAN.



CLOSING ANGLE OF AN IRREGULAR FIGURE.

Tracing Cloth with Both Sides Dull.

I would like to ask if any of the readers have a method for substituting a dull surface for the glazed side of tracing cloth, thus giving two dull surfaces. We write our specifications, pattern lists, etc., on tracing paper, printing on both sides on a typewriter, the print on the back side being produced by means of carbon paper. If tracing cloth could be used with each side dull, the blue print would be clearer and the original much more durable.

D. T. R.

Cast-Iron Beams—The Neutral Axis and Its Location.

Mr. Osborne's recent article touching on the relative strength of a T-shape beam with respect to the position of the cross-bar has furnished a reason for the following.

He has pointed out very cleverly the mistake many make in the selection and use of rules and formulas of which the meaning to them is but faint. His recital of the rule covering the location of the neutral axis will be familiar to many of your readers and is but an example of the blind instruction that is obtained from certain sources. Information of that sort is of but little value, being much on a level with our Sunday magazine science. On the whole little is gained by the short cuts that the present rush of affairs is liable to carry us. "Slow-but-sure" is the best policy. A little knowledge well assimilated is much better than a whole course in engineering gulped down without chewing. A good hot argument among your shopmates will be found a good way of obtaining useful knowledge which will stick. Mr. Osborne's article savors of

just such an argument and is but a common occurrence in any large shop where conflicting ideas run wild. What would a man's shop experience be worth without these word battles? Even the youngest apprentice can start such a battle which is liable to draw even the old man into the engagement.

For the benefit of those who, like Osborne's young man, may take for granted the literal meaning of such rules it may be of interest to mention some of the assumptions necessary in deriving the accepted rule for the location of the neutral axis.

In considering the flexure of a beam we assume that the fibers on the convex side of the member are in tension and those on the concave side in compression. The tension and compression causes a lateral lengthening and shortening of the fibers according to their location. It is easily seen that there is one portion of the beam which has neither tension nor compression and is the turning point of the internal action produced within the beam. This strip of fibers is called the neutral plane, and contains the neutral axis.

It is also assumed that the forces producing flexure are applied perpendicularly to the axis of the beam and lie in one plane, which is called the force plane and which contains the axis of the beam and cuts its cross section symmetrically.

The principal assumption bearing on the location of the neutral axis is, that the extension or contraction of the fibers between adjacent sections of the beam bears a fixed relation or ratio with their distance from the line of no tensions or compressions. In order that the above may hold, the material must be homogeneous throughout the beam.

The location of the neutral axis is dependent more than from any other reason upon the relative distortion of the material under tension and compression, that is, the ratio of elongation, due to the tension, to the shortening effect of compression, determines to a large extent the location of the neutral axis. It is common in most materials used in machine construction to assume that the distortion is equal under the action of equal tension and compression. This gives us a coefficient of elasticity of equal value for either force.

With these assumptions in mind the location of the neutral axis is found.*

It has been assumed in the method of demonstration that the distortion is proportional to the force causing it, that is, the elongation or contraction is equal per unit load or stress, and as is well known this holds good only within the elastic limit of the material. In the case of cast iron we have a material which has widely different values for the elastic limits of tension and compression; that for compression may be roughly set as twice as great as that for tension, but the distortion per unit stress is the same within the elastic limit. Therefore we see that the beam would give out on the tension side first.

If we take a beam of rectangular cross section and look into its action under strain we will find just what relation the load has to the location of the neutral axis.

It is easily seen that the distortion of the fibers will be equal within the least elastic limit of the cast iron, that is, the lengthening will be the same in amount as the contraction until we reach the stress equal to the elastic strength of the material in tension; consequently the neutral axis will coincide with the gravity axis of the beam up to this point. The elastic limit of cast iron is placed at 9500 pounds for tension and 19,000 pounds for compression. But the material does not rupture at this stress but continues to stretch until the stress reaches 18,000 pounds which is very nearly the value of the elastic strength for compression. The elongation after the elastic limit is reached increases very rapidly as the stress is increased; therefore we see that the neutral axis must shift as the conditions of the equal distortion have been violated. This shifting of the neutral axis increases until the beam is broken. From the above we also see that the beam if made of cast iron will always give way on the tension side and the break is caused by tearing but never by crushing.

From the above reasoning we see that if the elastic limit for tension is not exceeded a beam of T section or any other section will hold as great a load no matter which way the head is held, that is, up or down. And the deflection will be as great in either case, because the neutral axis coincides with the axis of the center of gravity for all loads within the least elastic limit.

It must also be kept in mind that an addition of metal on the tension side of a beam does not add more strength to the beam per unit of weight, as every addition to one portion only serves to shift the center of gravity to equalize the metal as a whole and with it is also shifted the neutral axis.

The above all goes to show what the "Accepted Theory" has to show as the reasons for location of the neutral axis, which can for all ordinary calculations, when the assumptions upon which it is based are known, be taken as common with the gravity axis.

A few modifications will have to be allowed in practice if we work down to fine points to counteract experiences such as Mr. Osborne cites.

We are all familiar with the great variations in the make up of cast iron. How little can be taken for granted in any dealings with it! We all know that even in the same test piece widely different figures are obtained when researches are made into its peculiarities. We know that one end of a bar will be a great deal harder than the other. Thin sections are always more liable to give way under stress than heavy thick sections. We know that the way a piece is laid in the mold or the way it is poured and whether it cools fast or slowly make a great difference in its qualities. Very little reliability can be placed even on test pieces out of the same ladle with the material to be used. So that very large factors of safety must be used in all calculations dealing with this mysterious but useful material.

JOHN EDGAR.

*Mr. Edgar has given here the usual demonstration by the use of calculus that the neutral axis passes through the center of gravity, which we do not think it necessary to reproduce; it can be found in the textbooks on mechanics.—Ed.

Winding Long Springs.

We all know how to wind a spring on a mandrel, not so many of us know how to run a spring-winding machine, and few of us know a better way than either. For those that do not know the better way I will try to give enough information so they can work it out, as each problem has

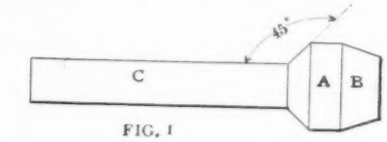


FIG. 1

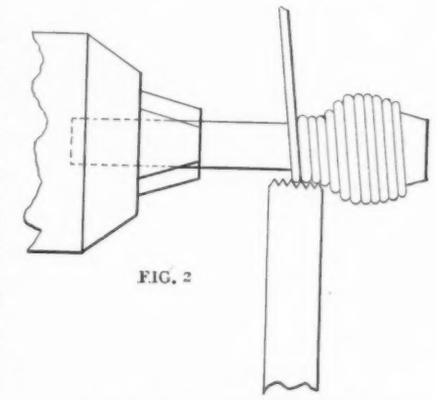


FIG. 2

THE MANDREL AND THE WORK.

to have some "cut and try" in it on account of the variations of temper in metals.

The only thing to be made is a mandrel, Fig. 1, the length depending on the size of wire; for No. 20 B. & S. gage 1½ inches is long enough. The diameter of the small part *C* to be the same size as an ordinary mandrel for winding the same size spring, the angle to be about 45 degrees, the larger diameter *A* to be as large as possible without giving a permanent set to the spring, and its length to be three times the pitch of the spring. The end *B* is tapered so as to let the spring slide off easily.

To wind the spring, place the mandrel in a lathe chuck. Select a thread chaser of about the pitch of the spring you are to wind, place it in the tool post in a position to bear evenly on the mandrel. Wind the small straight part of the

mandrel full of wire by hand with the free end toward the point. Push the spring thus made over the larger part of the mandrel till you have but 3 or 4 turns left on the small part. Bring up the chaser so as to engage these turns and start the lathe—see Fig. 2.

The pitch of the spring will be modified by the distance between the chaser teeth, the bevel of the mandrel and the angle of the bevel. The shorter the distance between the chaser and the bevel and the steeper the bevel, the closer the spring will be wound.

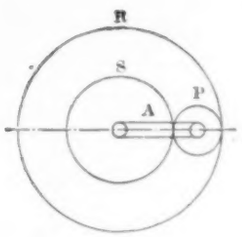
The length of the spring will be limited only by the length of the wire; and the speed of the winding by the fastest speed of the lathe.

See that the wire runs smoothly in the chaser; if there is any cutting, the cutting edges of the chaser will have to be rounded. J. BERTRAM.

Planetary Gears.

Andrew Strom's article on this subject at page 830, Vol. 29, Part 1, interested me very much. There is, however, much greater scope and many more useful movements than those shown in his drawings. I have had a great deal to do with planetary gears during the last few years for use in motor-car work, and I find that great use can be made of the revolutions of the planet pinions around their own axes. I therefore venture to send along the two tables of formulas enclosed herewith. Table 1 gives the formulas for simple, and Table 2 those for compound epicyclic trains. It will be seen that the results obtained by this table are exactly the same as those obtained by Mr. Strom, with this exception, that whereas his results are expressed as ratios (2 to 1, 3 to 1, etc.) mine show the revolutions of the driven member for each one of the driving member, and to express this as a ratio of reduction it is necessary to further divide the result into 1.

I am pleased to see that Mr. Strom emphasizes the necessity for having the number of teeth in the internal and sun pinions divisible by the number of planet pinions it is intended to use. I found this out for myself about three years ago, by the simple method of making a set of gears which would not go together. NEMO.

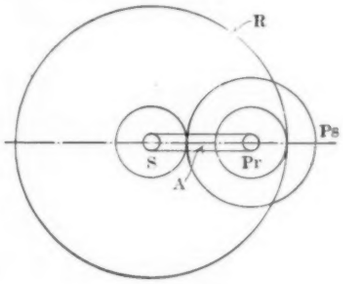


Case	Stationary Member	Driving Member	Driven Member	Revolutions of Driven Member per one of Driving Member	Revolutions of Planet Pinions on their own Axis per one of Driving Member
1	A	S	R	$\frac{S}{R}$	$\frac{S}{P}$
2	A	R	S	$\frac{R}{S}$	$\frac{R}{P}$
3	R	A	S	$\frac{R+S}{S}$	$\frac{R}{P}$
4	S	A	R	$\frac{R+S}{R}$	$\frac{S}{P}$
5	R	S	A	$\frac{S}{R+S}$	$\frac{S}{R+S} \times \frac{R}{P}$
6	S	R	A	$\frac{R}{R+S}$	$\frac{R}{R+S} \times \frac{S}{P}$

The Letters may denote either Diameters or Numbers of Teeth

A = Arm or Cage carrying Planet Pinions
S = Sun or Central Pinion
P = Planet Pinion
R = Internal Gear

TABLE 1. SIMPLE EPICYCLIC GEARS.



Case	Stationary Member	Driving Member	Driven Member	Revolutions of Driven Member per one of Driving Member	Revolutions of P_S & P_T per one Revolution of Driving Member
1	A.	S.	R.	$\frac{S}{Ps} \times \frac{Pr}{R}$	$\frac{S}{Ps}$
2	A.	R.	S.	$\frac{R}{Pr} \times \frac{Ps}{S}$	$\frac{R}{Pr}$
3	R.	A.	S.	$\frac{Pr\,S+Ps\,R}{Pr\,S}$	$\frac{R}{Pr}$
4	S.	A.	R.	$\frac{Pr\,S+Ps\,R}{Ps\,R}$	$\frac{S}{Ps}$
5	R.	S.	A.	$\frac{Pr\,S}{Pr\,S+Ps\,R}$	$\frac{Pr\,S}{Pr\,S+Ps\,S} \times \frac{R}{Pr}$
6	S.	R.	A.	$\frac{Ps\,R}{Pr\,S+Ps\,R}$	$\frac{Ps\,R}{Pr\,S+Ps\,R} \times \frac{S}{Ps}$

A=Arm or Cage carrying Planet Pinions
R=Internal Gear
S=Sun or Central Pinion
P_T=Planet Pinion Gearing with Internal Gear
P_S=Planet Pinion Gearing with Sun Pinion

TABLE 2. COMPOUND EPICYCLIC GEARS.

Factors of Safety — Some Things Suggested by Life in a Cottage.

I am down here, not to rest, but to get a change, or to get sufficiently disgusted with the city people's idea of having a good time so that I will be glad to get back to work. This is a great country down here; some of it seems hardly finished, it is so rough, but there are plenty of rich people that can afford to have it polished off to suit them. Then, too, there are quite a few people like myself that can come down here on quite a slim pocketbook, and who prefer to leave the country as God made it, and just sit on the sand and think, or, by way of variety, just sit, as one of these Gloucester fishermen said so long ago that the patent has run out. Just today I have been thinking about factors of safety. What led up to it was seeing our landlord climb up on our kitchen roof to fix it. By all the formulas that I know of he ought to have gone through, but he did not. The roof of this cottage shows three distinct stages of time and cash. Part of the roof is steep and has 2x4 rafters, 4 feet centers; part of it is about 30 degrees to the horizontal and has 2x4 rafters, 2 feet 6 inch centers; but the kitchen is about 10x20 feet and is almost flat. There are no rafters. The roof boards reach across the short way. They are supported only by a 2x6 laid "flat-wise" which runs lengthwise through the center. This in turn is supported by a 2x4 laid edgewise at right angles to it and through the center. Now this roof

has been here for several years. It stands the wind pressure and snow pressure and evidently landlord pressure. What more do we want? It proves that in the other parts of the roof there is a waste of material. A great many cottages here are terribly light in construction, but I haven't seen any direct ill results. One cottage had its foundations swept out from under it in the winter's storms, but even that does not appear to be badly racked, in spite of its flimsy construction.

There seem to be two distinct ways of arriving at the correct factor of safety. One is to begin by making things decidedly too strong and then cutting down little by little till they begin to break. Then make them just a trifle stronger. The other is to begin with them a good deal too weak and gradually strengthen them till they give out only occasionally. The two methods will not give the same result in a given time. The first one is slow. The customer who has bought a heavy, clumsy machine and is used to it will be certain that you are cheating him if you leave off a pound weight, even if you can prove to him that he is the gainer thereby. The other man who is used to your light, handy, easily transported machinery will not for a moment stand its being made clumsy. This inertia of the purchasing public has just as far reaching an effect as any consideration of mechanics. From one point of view this matter of a factor of safety seems absurd. We know that if we take a number of steel beams of a given section and length that they will all stand the same load within a comparatively small per cent. We also know that if these beams are each subjected to repeated stresses that they will break at certain other loads, but those loads are pretty closely known. We know that a little smaller load will not break it. But before we dare to use it we will put in a factor of safety of anywhere from four up. We say to ourselves, "We expect to load this beam with so many thousand pounds, gently applied and evenly distributed." We compute it on this basis. Then we say that we know that in the course of time some accident will happen that will subject it to other stresses. Consequently we make it a certain, or rather, uncertain number of times as strong as we have already figured it. All of which seems to me like making a trunk four or five times as strong as if it was always to be lifted in its natural position by the two handles. After what I have seen lately, if I were called on to design a trunk, I would first make it strong enough to stand about 100 lbs. per square inch internal pressure and then figure on its being repeatedly dropped about 10 feet when under full load and striking on one corner; but I don't think I would pay the slightest heed to the strength as related to its legitimate use.

There is a pretty determinate set of accidents that may happen to anything. Some of these accidents we can guard against by making our designs strong enough to stand them. Others we either cannot afford to take care of this way, or we do not want to because we prefer the part in question to give way rather than some other part which is more important. So far this question of accident has been treated in studying mechanical matters almost alone, as something to be covered, like a multitude of sins, by a factor of safety. It seems as if now was about the time that we ought to begin to study and analyze accidents. I am going in now and see how much stronger this kitchen roof ought to be, so that it will be all right to stay under next week when that lunkhead comes to fix the chimney. If he should tumble off into it as it is now, I feel morally certain that outdoors would be the safest.

ENTROPY.

Gloucester, Mass.

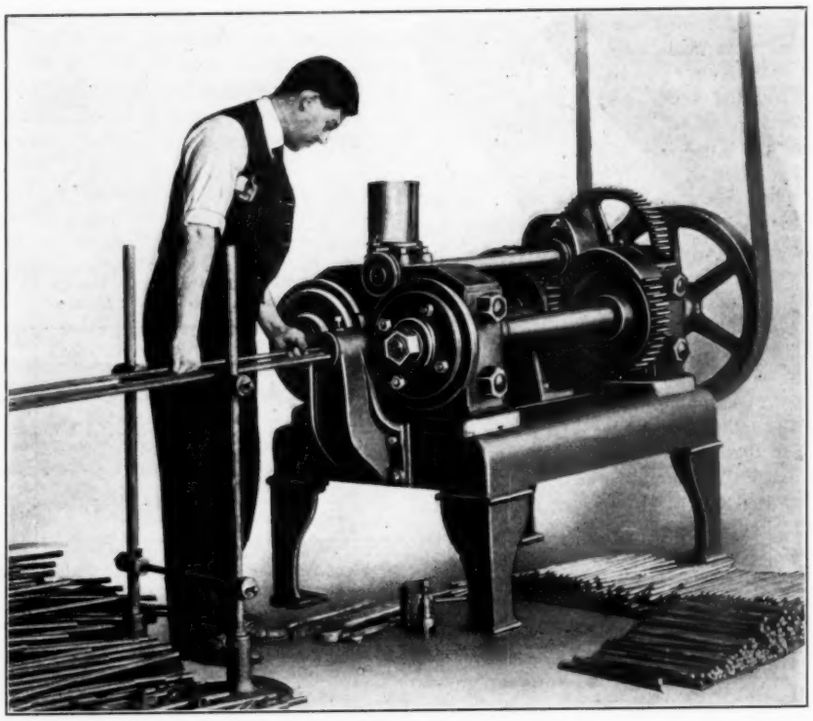


FIG. 1. GENERAL VIEW OF CUTTING-OFF MACHINE.

A Novel Cutting-Off Machine.

The illustrations show a machine that was built by The Westinghouse Electric and Manufacturing Company for cutting off round stock up to 5/8 inch diameter and gas pipe up to 1/2 inch, in large quantities. The speed of the cutters is 20 revolutions per minute and allowing 25 per cent. time loss getting stock and cut-

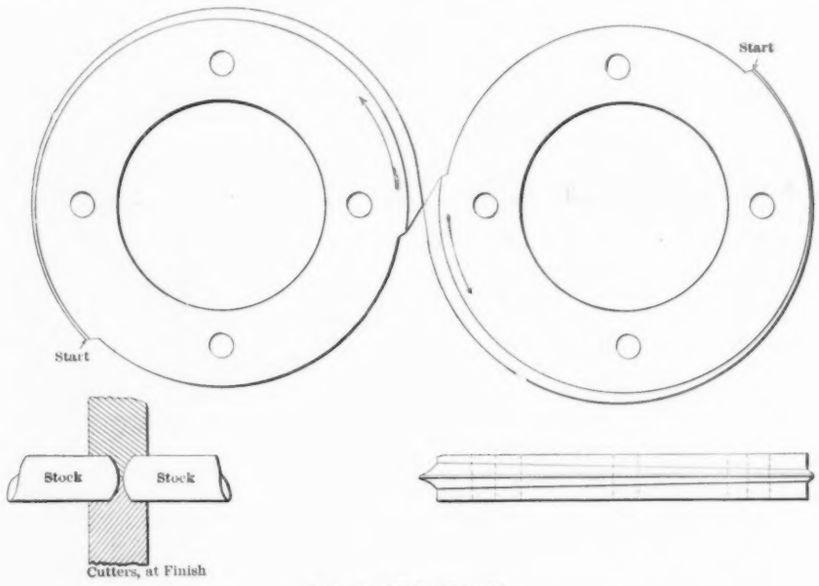


FIG. 2. THE CUTTERS.

ting ends, we get 900 pieces per hour; whereas in cutting in a screw machine we get 600 in 10 hours. The cutters are 15 inches diameter and made to leave the end of the work rounded. They both run in the same direction, as indicated by the arrows in Fig. 2, so that the bar being fed between, the one cutter edge is going up while the other is going down, rolling a groove in the stock. The groove is started about 1/32 deep and gradually gets deeper until the two cutters meet and the rod drops off. A part of the cutter circumference is cut out to allow the operator to pass the bar up to the stop. The bar rotates when being cut off, the action being similar to placing a pencil across and between the hands and drawing one hand toward and pushing the other from you, thus causing the pencil to turn. When designing this machine, some had doubts about the stock revolving, thinking there would be two flats pressed in the stock. We found no trouble from this unless the cutters were set too close at the start.

The machine was built to cut rods up to 30 inches long. The cutters were cut in a lathe, starting the tool at the finishing point and backing off one side with the gearing set for four threads per inch. The opposite side was backed off by feeding as for a left-hand thread. It was rather a peculiar job to make. After hardening, the cutters were ground in the lathe in the same way. McK.

The freight-train crews on the Galveston, Harrisburg and San Antonio Railway, between San Antonio and El Paso, Texas, can now keep in touch with what is ahead of them and behind them with much more thoroughness than formerly, for each caboose has been provided with a telephone instrument and a fish-pole connection, so that no matter where he stops or is stopped, the conductor can quickly communicate with the train despatcher, or any other office. This is a similar arrangement to what was provided on the electric locomotives which haul trains over a portion of a large railroad, when, some years ago, the third rail was laid on that track. Among other provisions against prolonged interruption of traffic, a telephone line was strung at about the hight of the cab, so that if he should become stalled the motorman could reach out of his cab window with a rod and contact device to the wire, and with his portable telephone call up the power house, battery house, towerman, etc., as necessary. We believe, however, that much occasion did not arise for using the device in this case.

The United States now has an American cable communicating with its Pacific Ocean territory and with China. After several years of work and delays the last link (Manila to Shanghai) of the line from San Francisco, has been completed.

Automobile Working Drawings.

BY HUGH DOLNAR.

The motor car is at the present time in such a condition of constant change as to prevent anyone from laying down a complete plant of the best and most labor-saving tools possible for producing the parts of any model. The most that anyone has tried to do, so far, is take the most suitable general tools to be had, and make a partial set of jigs and then go ahead and put cars together the best way possible.

The conditions are these: there is a yearly show at which every maker intends to show something better than his last year's exhibit. This of course demands changes, and these changes may be great or may be small, but are pretty sure to be many in number. At the show all of the designers see new things, and begin at once to think about next year's changes, and, also, at the shows the selling agents make their orders for the current season, the principal show having heretofore been held in New York, in the latter part of January. The agent wants machines as soon as possible after giving his order, and as it is always all the designer can do to have his new model ready for the show there is no time for special tool-making, and the cars must of necessity be got out with general tools, and such jigs and templets and special tools as there is time to make.

It has been proposed to obtain more time by holding the show earlier, in October of the year, but many makers fear to show new features in time for rivals to copy them for the season's trade. Even if the show were in October it would not help much about special tools; these can be fully developed only when the builder is sure the model will be in demand for some years at least, and so far no one expresses that degree of confidence in his own productions.

This certainty of constant changes has led the more experienced motor-car builders to use a drawing-room system specially adapted to the making of changes, large or small, in the completed car, and to the discarding of drawings at the least expense.

The first feature is to make the drawing sheet small in size, and to give each piece a separate sheet, the only standard parts being fillister- and round-headed machine screws and split-pins, or as they are often called "spring cotters," which is far from right. A "cotter," in English shops, is what we call a "key" in America, and a "cotter pin" is a split pin in the small end of a connecting rod key. "Split-pin" is correct here.

A great variety of materials is used in the motor and car, and it is more convenient to designate the material by special hatchings than to write the name of the material on the drawing, which is probably the less liable to be mistaken.

I have some drawings from the "Reo" shops, Lansing, same manager and chief draftsman as in the "Oldsmobile" shops, Lansing, the first establishment to produce small motor cars in very large numbers.

The chief draftsman was a shop man first, then a "Teck," and then a shop man again, and though yet young has had experience enough to be sure he knows what he wants and how to get it, which gives practical value to the methods he has adopted.

Small sheets of abbreviations and hatchings, and of split-pins and round- and fillister-head screws are the only general sheets in the Reo drawing room. All hex and square-head screws and bolts rate as special or separate pieces, and each has its own drawing sheet, and as there are between 7000 and 8000 pieces in the simplest single-cylinder Reo car, including screws, pins and rivets, there are a good many sheets of drawings and tracings in the Reo drawing room.

The bolts and screws which have separate drawings take plain numbers in sequence, and are hence easily indexed. Machine parts, like the carbureter body, are identified by a symbol, "2AH12" for instance, which is decidedly special, and of course makes the indexing special, too.

I have never yet seen complete lists for any American automobile model, and doubt the existence of such an exhibit, in any drawing room, though some motor "instruction books" give pictures and names of all parts likely to be ordered as repairs.

Every separate bolt or screw has a ruled space, narrow column each side of a middle wide space, for specifying the number wanted, the "place," that is the location in the car, and the model of car, with 27 entry spaces under each head.

The sheet title carries the name of the part and its symbol also, and the "superseding" line, which takes the date of the drawing made obsolete by the present sheet, if any, and the "superseded by" line, which takes the date of the next following change, and the date line, followed by the "O K'd," or checker's signature line, which is supplemented by the chief draftsman's check, making the top man take the blame if any blame comes. The same drawing serves for all shop departments.

To the left of the sheet title is the blue printer's date. The title lines make it easy to run down the history of a component in the shop, day and date, all that went before it and came after it, with no questions to ask of anybody, and as this system was adopted in response to very urgent factory demands, and was working smoothly when observed, and as much the same system is in use in other motor-car works, the "Reo" drawing system is well worth notice.

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More Excellent Work by the British Standards Committee.

We have previously referred to the work of the British Engineering Standards Committee, which is supported by the various technical and engineering societies of Great Britain, and which has undertaken to make investigations with a view to finding out what are the best standards for manufacturers generally to adopt, and then to set forth what these standards should be, or what they are. The work being done by this committee is of the most thorough and comprehensive character, and none of the reports so far issued better illustrates this than three numbers we have recently received, being Nos. 20, 21 and 27, devoted respectively to British Standard Screw Threads, British Standard Pipe Threads and British Standard Systems for Limit Gages, the latter being for running fits only. The first of these is what is called an interim report; the others, we understand, are final. There has been much criticism of the engineering practice of Great Britain on account of its alleged unusual or extraordinary lack of standards. If, however, the manufacturers of Great Britain give the attention to the reports of this committee which they deserve, Great Britain will be the most thorough and best standardized manufacturing country in the world.

In the reports before us we find many interesting things. In that relating to standard screw threads, for instance, regarding which we often have inquiries from American manufacturers, we note that in the preface the committee states in effect that, owing to the different meanings attached to the same terms in different localities, it was found necessary first of all to agree upon the terms to be used and the meanings of them; in other words to decide upon nomenclature and the definitions to be employed. The committee also made a very full investigation of the different forms of threads that are in use, and its conclusion from the evidence laid before it was to sustain the general use of the Whitworth thread and not to recommend any departure from that form of thread; it being promised that in a subsequent report methods of originating the tools for producing this thread will be fully given. It is also stated that the Whitworth standard pitches for screws of ¼ inch to 6 inches diameter inclusive do not fully satisfy all requirements, and that for certain purposes where threads are subjected to shock and vibration, or where extra strength is required in the core of the screw, finer pitches are desirable. We may add that this also has been found desirable in this country with respect to the Sellers or Franklin Institute thread, and that such finer threads are much used here, though they are not standardized as they now are in Great Britain.

In that part of the report which deals with nomenclature and definitions, we find many admirable things, and things well calculated to dispel some of the fogginess which prevails regarding the exact meaning of terms of common use in engineering. For instance, most people here, as well as in England probably, have very indefinite ideas as to the meaning of the terms "tolerance," "allowance" and "clearance." Many people think they mean much the same. They are, however, in this report given different distinct meanings, tolerance meaning a difference in dimensions or a variation from nominal size, permitted in order to compensate for unavoidable imperfections of workmanship. Allowance is a variation from the nominal dimensions to allow for various qualities or character of fit; while clearance is a difference in dimensions prescribed in order that two surfaces or parts may clear one another. These distinct definitions are carefully kept in view throughout the report and do very much to make it clear and unmistakable.

The different classes of gages are likewise clearly distinguished. A standard gage, for instance, being one which is suitable for being deposited with some recognized authority for purposes of ultimate reference. Reference gages on the other hand are copies of the first named gages and are intended for use by manufacturers and others for checking the shop or working gages. They are to be verified and their accuracy certified by the authority in whose custody the standard gages are deposited. Limit gages are for insuring that any given dimension will be within the tolerance prescribed for the work.

Excellent and clear definitions are given for the various parts of a screw, such as its "effective diameter," its "core diameter," "full diameter," "crest," "root," "slope of thread" and "angle of thread," "pitch," etc., and finally there is a table giving all dimensions of standard screws from ¼ inch to 6 inches diameter inclusive, carried out to four decimal places, for "British Standard Whitworth Screw Threads," for "British Standard Fine Screw Threads," and for "British Association Screw Threads," the dimensions of the latter being given in millimeters, presumably because they are used for screws employed in scientific and instrumental work and metric dimensions are well established for them.

The report on British pipe threads is equally thorough, comprehensive and satisfactory. It starts by giving clear definitions of the terms used and ends with tables giving the dimensions of standard pipe threads of nominal bore of pipe from ⅛ to 18 inches inclusive, with all particulars of sizes, pitches, etc. The committee states that after full consideration of the arguments presented in favor of the use of the Sellers or Franklin Institute thread for pipes, its conclusion has

been that the arguments had not been sufficient to justify recommending its adoption for this class of work, and it is recommended, therefore, that the Whitworth form of thread be retained, which, as our readers know, has an angle between the slopes of the thread measured in the axial plane of 55 degrees and has its threads rounded at the top and bottom, or as the committee state it, at the "crest and the root," sufficient to leave a depth of thread approximately equal to 0.64 times the pitch. It is noticeable that the table of dimensions given makes no provision for tapered threads on a pipe, though conical threads are mentioned in the report, which says that "there are two classes of threaded connections which are recognized by the committee, class 1 being the ordinary or short screw, and class 2 the long screw. In class 1 the thread on the end of the pipe is conical, having a taper of 1/16 inch in an inch of length," the internal thread to which this is to fit being "either parallel or conical, as may be required."

In the report on standard limit gages for running fits we note that the committee is of the opinion that for running fits the shaft should be the element more nearly approaching the true or nominal dimension, and that the allowance should be made in the hole, according to the class of fit required. This we do not quite understand and believe that it is general practice in America to make the allowance the other way; that is, generally, to make the hole as close to the standard as may be, and allow for the character of the fit by varying the diameter of the shaft or internal member.

As an illustration of the great advantages of having specific and clearly defined nomenclature, we may quote from this part of the report as follows: "The tolerances of the shaft are negative in order that it may never exceed its true dimensions. A minimum allowance is specified between the two elements, and this cannot be encroached upon by either element. Above this allowance a positive tolerance is laid down for the whole."

In this report four classes of work are recognized and tables giving different tolerances and allowances for the different classes are given. The tables themselves, however, refer to the different classes as the first, second, third and extra fine "qualities" of work, and here it seems to us there is perhaps a slight confusion and that the use of the terms "quality" or "class" in this connection may at times be somewhat misleading, the fact being that it sometimes happens that a piece of machine work having greater tolerances and allowances than another may nevertheless be of a higher or better quality of workmanship. An interesting result of the committee's careful work in arranging the gages is that, as pointed out, should occasion demand, "the allowances laid down for one class of work and the tolerances laid down for another may be employed together without effecting interchangeability."

As showing the difference between the various classes or qualities of work mentioned, we find that, for work having a nominal diameter of 1 inch, in the case of the "extra fine" quality of work, the shaft may have a minimum diameter of 0.9995 inch and a maximum diameter of 1 inch, while the hole may have a minimum diameter of 1.0005 inch and a maximum diameter of 1.0010 inch; for the "first-class" work the shaft may have a minimum diameter of 0.999 inch and a maximum diameter of 1 inch, while the hole may have a minimum diameter of 1.001 inch and a maximum diameter of 1.002 inch. For the second quality of work the shaft may have a minimum diameter of 0.998 inch and a maximum diameter of 1 inch, while the hole may have a minimum diameter of 1.002 inch and a maximum diameter of 1.004 inch; for the third class of work the shaft may have a minimum diameter of 0.997 and a maximum diameter of 1 inch, while the hole may have a minimum diameter of 1.004 and a maximum diameter of 1.008. It will be noted here that the tolerances are such that the sizes of the shafts and of the holes can never overlap each other. There will always be the intended minimum difference in diameter between shafts and holes, which, however, may be as much greater than this as has been provided for by the schedule.

These reports we consider to be of the highest order of excellence. They are capable of working very much benefit to British manufacturers in general, and we believe they will be found of great use in many American machine shops as well.

More Gold, Higher Prices and Higher Wages.

A short while ago we referred to an article in one of the financial magazines on the effect of the increased production of gold upon prices. A London financial journal takes up this subject and cites the increase which has already taken place, indicated by the figures showing that in 1883 the yield of the gold mines was 4,614,588 ounces, whereas for 1905 it was 18,211,419 ounces. It is prophesied that this great production will be largely increased, and that prices will advance enormously during the next 15 years. Reference in this connection is made to the claims put forth in recent political campaigns here in America to the effect that a greater volume of money was actually needed. We now have that greater volume of money with the "better" i.e., higher prices which it was predicted would accompany it.

We might add that workmen may have noticed a phenomenon which it was also predicted would accompany an increased amount of money, and that is that the prices of things they buy have gone up much more, and much more rapidly than have wages; living expenses having notoriously increased much more than have fixed incomes of workmen, salaried men, etc.; many men working for salaries being in fact now in receipt of the same income they received before the large increase in expenses of living occurred.

The Bureau of Labor at Washington is at variance with private statisticians in this matter and has figured out that the purchasing power of the higher wages now paid is greater than was the case in 1894 and only 2.7 per cent. less than in 1896. This conclusion was arrived at by taking only those industries in which the total annual wages amounted to $10,000,000 a year or more.

In such matters as these, people have a way of arriving at general conclusions based upon their own experience and that of their neighbors and friends. The conclusion thus arrived at and sustained by figures from other sources will not probably be much altered by any amount of figures published at Washington showing a different state of affairs. Accurate household expense accounts are rare, however, and conclusions that are mere "impressions" are notoriously likely to be very deceptive.

The United States Civil Service Commission announces an examination on September 12-13-14, 1906, to secure eligibles from which to make certification to fill a vacancy in the position of engineer draftsman, at $1,500 to $2,000 per annum, in the Reclamation Service, Geological Survey, and similar vacancies as they may occur in any branch of the service.

This examination is open to all citizens of the United States who comply with the requirements.

Applicants should at once apply, either to the United States Civil Service Commission, Washington, D. C., for Application Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for this examination the exact title—Engineer Draftsman, Sept. 12-13-14, 1906—should be used in the application.

As examination papers are shipped direct from the Commission to the places of examination, it is necessary that applications be received in ample time to arrange for the examination desired at the place indicated by the applicant. The Commission will therefore arrange to examine any applicant whose application is received in time to permit the shipment of the necessary papers.

The American cable to China runs from San Francisco via Honolulu, Guam and Manila to Shanghai. Its construction was delayed by the Chinese and the Japo-Russian troubles. The average depth for 10,000 miles is 2640 fathoms, and the greatest depth 3490 fathoms.

New Publications.

"Large Steam and Electric Locomotives." J. E. Muhlfeld. 28 pages, 6x9 in.; paper. A pamphlet just issued by the American Locomotive Company presents a paper read before the New York Railroad Club by J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio Railroad, reproduced with extracts from the discussion, by permission of the club. As frontispieces for the pamphlet the Mallet Articulated Compound, No. 2400, built by the American Locomotive Company for the Baltimore & Ohio, and the electric locomotive No. 7-8, built by the General Electric Company for that road, are shown; these are respectively the heaviest steam and the heaviest electric locomotives yet built, the latter consisting of two units operated as one locomotive. The paper opens with a description of the electric locomotive illustrated in the frontispiece, giving details of design, record of its performance since going into service in 1903, and statistics of the average cost of operation and maintenance per hundred miles run. Then follow several specifications of the requirements an electrical locomotive and its source of power should fulfil, to produce efficiency and economy in railroad service. The next seven or eight pages are taken up with a description of the Mallet Articulated Compound, illustrated in the frontispiece, giving special features of design, and comparing it as to total weight, tractive power and hauling capacity with two consolidation locomotives which together were formerly required to do the work now done by the Mallet. Then follows a record of the performance of this locomotive for a period of one year—from January 1905 to January 1906—and a report as to the general condition of the machinery and boiler at the end of this time. Mr. Muhlfeld then goes on to mention some of the results obtained from this type of steam locomotive, which he considers cannot be duplicated by other single units of steam, electric or internal-combustion locomotives yet put into service on American railroads, and to give a short résumé of the requirements which modern railroad motive power must fulfil. Following this is a statement of equipment necessitated by the use of electricity for motive power and that required where the steam locomotive is used, and a summary of the general features for a modern locomotive. In the last three or four pages of the paper, the possibilities for electrification which some mountainous steam railroads present are pointed out, followed by a general discussion of the subject of steam versus electricity for motive power. Mr. Muhlfeld compares the electric and steam locomotive from the standpoints of efficient and economical operation and maintenance, pointing out the necessity of reducing the initial cost of electrification by increasing the efficiency and economy of present types of stationary boilers and by improvements in the means of generating, distributing, converting and transmitting electrical current. In conclusion the author says that it is only by the harmonious co-operation of the electrical and mechanical engineer, attacking the problem from the transportation and motive-power standpoints, that we can hope to meet the present and future motive-power requirements. The rest of the pamphlet is taken up with discussions of Mr. Muhlfeld's paper by F. J. Cole, H. H. Vaughan of the Canadian Pacific Railway, W. B. Potter of the General Electric Company, Angus Sinclair and W. M. Smith, closing with a summing up by Mr. Muhlfeld.

"The Runnerless Slide Rule." By F. F. Nickel. 38 4½x5¾-inch pages. Published by the Author, East Orange, N. J. Price 50 cents.

This pamphlet is in effect a protest against the prevailing or Mannheim construction of slide rule which the author regards as an improvement backward. Inasmuch as the popularity of the slide rule in this country began with the introduction of the Mannheim arrangement, many users of the instrument do not know that the standard form of English rule for many years prior to the appearance of the Mannheim differed from the Mannheim in that the lower or *C* scale of the slide was divided like the upper or *A* and *B* scale of stock and slide, the lower or *D* scale of the stock only being graduated to a double radius. The double lower slide or *C* scale was introduced with the runner and with this arrangement of scales the runner is a necessity for problems in which squares or square roots enter, whereas with the older arrangement these problems are solved by directly comparing the *C* and *D* scales. The object of doubling the radius of the *C* scale in the Mannheim rule was to enable problems in multiplication, division and proportion to be performed on scales of double the radius of those at the top of the instrument, and in order to accomplish this the facility of reading square and square-root problems, including, of course, the one which we have always with us—finding the areas of circles—by direct comparison of the *C* and *D* scales was sacrificed. The use of the lower scales for multiplication and division we do not like and never follow. It involves the constant and exasperating uncertainty that one never knows until he has tried it which way to move the slide and, by the fatality which attends such things, the first movement is usually wrong, while the use of these scales for problems in proportion involves the additional disadvantage that many of the simplest problems cannot be solved at all without a second setting of the rule. For these disadvantages the slightly increased accuracy is in our opinion no adequate offset, and we entirely agree with the author of the pamphlet that the old arrangement of scales which he revives, and for the use of which his pamphlet gives instructions, is superior to the Mannheim. At the same time we would not discard the runner for, while his rule without it is preferable to the Mannheim with it for problems involving powers and roots, it is nevertheless useful in those problems in multiplication and division which involve many factors and also in problems involving multiplying a whole number by a fraction when the terms of the fraction are not expressed by the lines of the scales.

The author supplies a rule graduated as he and we believe it should be. An excellent and new feature of it is the insertion of a blank strip of celluloid in the bottom of the groove in the stock in place of the usual strip graduated in millimeters. The author's idea is that the gage points which every user of the instrument works out for his own use shall be placed on this special strip instead of being placed on the face of the instrument where they disfigure and obscure the regular graduations. So placed the rule is set to them by making the end of the slide register with the marks. Not only does this provision avoid disfiguring the regular scales, but the provision of a special strip for the gage points gives room for more of them than any one user will need, and with so much room, they are far more clear and distinct than they can be on scales which are already fully graduated. The rule has celluloid faces with clear black graduations and is of superior workmanship. Its price is $3.

"Automobile Catechism." By Forrest R. Jones. 134 4½x7-inch pages with 11 illustrations. The Class Journal Company, New York. Price $2.

This manual is intended for the information of owners and users of gasolene automobiles. It opens with a description of the construction and operation of the leading parts—some of it decidedly elementary though probably not too much so for its intended readers—and then takes up the operation and maintenance of automobiles, troubles and their remedies, road repairs, etc., in a manner which should be decidedly helpful to the novice. The book is in the question and answer style, which seems to us unnecessarily cumbersome, but which, no doubt, is popular with those seeking elementary information.

Portland, Oregon, is said to be the largest lumber port in the world. Not long ago vessels for foreign ports were loading there, or under charter, to an aggregate capacity of 20,000,000 feet, and for home ports others having 5,000,000 feet more.

The Krupp establishment had 62,553 employees on April 1.

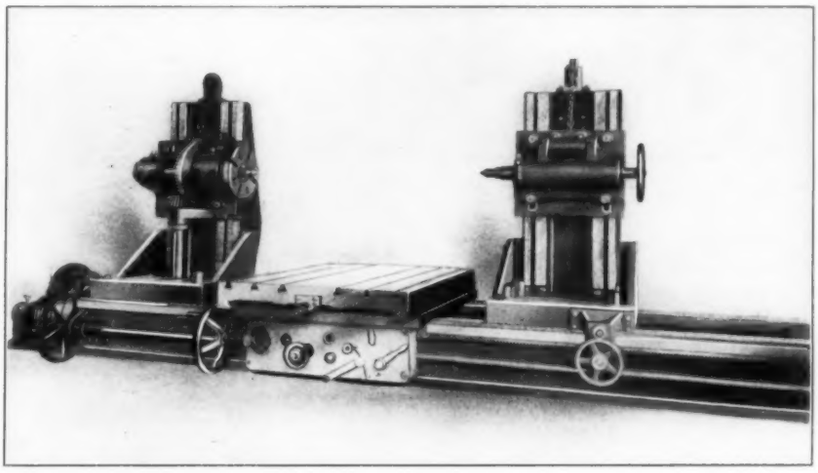
New Tools and Machine Shop Appliances.

A HORIZONTAL BORING MILL.

The illustration shows a horizontal boring mill with a swing of 84 inches over the table and 9 feet between the centers. The bed is 16 feet long, but beds any length up to 36 feet can be furnished. The driving head is double back geared with a 4-step cone for 4-inch belt; the largest step of the cone is 19¼ inches diameter and the smallest 10¾. There are 12 gradations of speed for the bar, from 1.6 to 100 revolutions per minute.

The table has a working surface 48 inches long by 63 inches wide with a cross travel of 52 inches by hand.

The head-spindle is 5½ diameter; it is driven by wide-faced, planed, bevel gears. The tail-spindle is 4 inches diameter; both spindles are fitted with centers, Morse No. 6 taper. Both heads are capable of adjustment by hand and can also be raised and lowered by power. The tail upright is moved along the bed by crank, gears and rack as shown.



A HORIZONTAL BORING MILL.

The tailstock is hinged and can be swung up out of the way—to remove boring bars, etc.—without losing its adjustment; this is done by loosening the two lower bolts which slide in elongated holes as shown.

Both the heads are counter-balanced. Screws from 1 to 12 threads per inch may be cut; the feeds range from 0.01 to 0.125 per turn of the spindle. With a 16-foot bed the machine, ready for shipment, weighs 30,000 pounds.

It is equipped with a friction countershaft, having two 20x4½-inch pulleys, which should run at 110 revolutions per minute. The necessary wrenches, change-gears, etc., are also supplied. This machine is built by the New Haven Manufacturing Company, New Haven, Conn.

BOTTLE GUARD.

Frank B. Rives, of Pittsfield, Mass., is manufacturing a bottle guard, which he recommends for the ink bottles that stand around drafting rooms, and which by being accidentally tipped over sometimes work much mischief. This guard, which is made of card-board and is very cheap, is designed to prevent the spilling of the contents when bottles are tipped over.

A SAND MIXER.

This machine is intended for mixing molding, core or facing sands. It is driven by electric motor, gas or gasolene engine. The machine consists of a series of revolving blades which cut and mix the sand and throw it up into a heap. The machine being on wheels can be moved about as desired. Under favorable conditions it will mix a heap of sand 60 feet long in less than three minutes. The machine complete weighs 650 lb. It is built by The Stockham Homogeneous Mixer Manufacturing Company, Piqua, Ohio.

Almost anyone, upon a little reflection, would perceive a number of apparently sufficient reasons why the editor of the *Novoe Vremya*, of St. Petersburg, should have very little to say on the subject of war, and especially to predict what will happen and what nations will triumph over others. Apparently, the editor of the *Novoe Vremya* fails to perceive any of these reasons, however, for he has indulged himself in a recent issue of his paper with a prediction to the effect that there will be war between Japan and the United States, and that Japan will attain a victory, will seize the Philippines and Hawaii and occupy California. The *Novoe Vremya*, as the representative of the grand dukes of Russia, has probably had as much to do with one notable triumph of Japan as perhaps any other single influence. It is not at all likely that Japan and the United States will come to war, and probably with our doughty editor the wish is father to the thought.

Design of Shafts for Carrying Sliding Gears.

BY WARREN NOBLE.

The design of driving shafts, where gears have to be slid along them for the purpose of a speed change, has been brought into prominence lately by the development of sliding gears for gear changing on automobiles. Naturally, evolution has been going on gradually as regards the general practice of construction, but there has been and is one fetish on which designers have immolated their work and sacrificed efficiency for years past. I refer to the driving shaft along which the wheels are caused to slide. The obvious construction is the common one, namely, a square shaft passing through a square hub. I need not emphasize to machinist readers the difficulties to be overcome in obtaining a job approaching accuracy with such a device. The shaft, it is true, can be made quite accurately by surface grinding after the oil-toughening or hardening process commonly employed to give the shaft the necessary strength, but the manufacture of the hub is by no means such a simple matter, particularly where it is of any length. An accurately square hole can be developed on a Fellows gear shaper by employing a 3 to 4 ratio with the change gear, but the length of the hole is limited and its minimum size somewhat large. Where a drifting process is employed the drifts are wearing heavily all the time, with the result that the dimensions of the work done by them vary considerably. Lastly, the amount of slack the hub must have on the shaft in order to slide smoothly is considerable. It is obvious then that gearing mounted on such a hub is not in the most efficient mechanical condition for correct running, since, apart from the difficulties of getting the gear to run true with the shaft, the slack allows of variation between the pitch line when under load that tends to noisy running and decrease of efficiency.

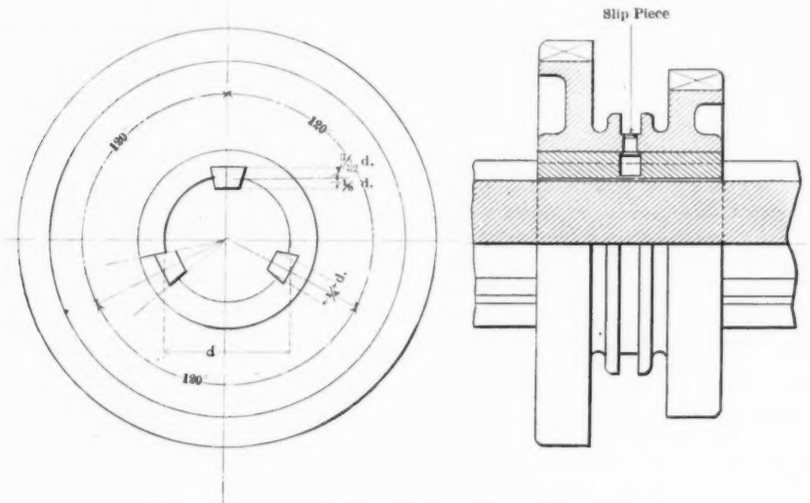
With continental automobile practice, these difficulties have long been realized and many attempts made to overcome them with the result that there are very few continental machines using a square shaft for driving the primary gear wheels. In place of it there is a tendency to use castellated shafts, the castellations being milled from the solid, in order to avoid inserted keys or feathers. The hubs of the wheels are drifted to suit these castellations. This method is a distinct advance upon the square shaft arrangement, but is somewhat difficult for manufacture, if the resulting combination is to be perfectly true. Where the keys are inserted, the problem becomes an easier one, since the shaft can be ground and the sliding hub ground or lapped before the keys are fitted; but there is rightly a great objection to having inserted pieces to the

shaft, although many makers are sacrificing their objections in this direction in order to obtain the necessary accuracy for the pitch lines.

The method which I am about to describe, I have found in practice to be superior to any of the above mentioned, both as regards cheapness of manufacture (in respect to cost and accuracy) and also, with regard to results. A glance at the illustration will indicate the design more explicitly than verbal description. Broadly, it consists simply in the employment of keys dovetailed into the wheel hub which mesh with keyways cut along the shaft. The angle between the sides of the key is that between the two radii of the shaft inclosing at the base of the keyway a segment equal to a quarter of the diameter of the shaft. The faces of the keyway are themselves radial. This dovetailing has a twofold purpose. It serves to hold the keys securely in the hub, and it also provides for an easier action when sliding takes place. As regards manufacture, the hubs are first turned and bored within a reasonable grinding allowance and the dovetailed keyslots then drifted. This having been done, the hub is ground out to a standard gage, finished over the top and the teeth cut. The shaft is made to standard and the keyways cut by a milling cutter, which leaves them 0.01 inch narrow. The shaft is then oil toughened, ground to the same standard size as the bore of the hub and mounted between centers on a cutter grinder and the keyways ground so that they are perfectly parallel and equally spaced. The hub is then lapped to a good sliding fit on the shaft, and the keys are fitted so that they bear equally on the similar faces of the three keyways. In the illustration shown, the keyslots in the hub of the wheel have square corners, but it is recommended for the sake of preservation of the drifts that these be rounded, and the edges of the keys chamfered to suit.

It may be contended that the drifting of these slots is much more difficult than the drifting of a rectangular slot, but it is now axiomatic that no screws should be used in the construction of an automobile gear unless quite unavoidable. The sectional view shows an excellent method of holding the keys endwise in the hub. Through the key is drilled centrally, or in some position to correspond with a clear portion of the hub barrel, a 5/16 or ⅜ hole. In the hub barrel is drilled in a corresponding position a ¼ hole. The slip piece shown in position is made from a piece of mild steel and is inserted when the key is in place before assembling the shaft. It is obvious that it is impossible then for this piece to get out, while it stops any end motion on the part of the keys, the dovetail, of course, holding the key in the other direction. It will be found that the adoption of radial keyways makes the sliding action more easy, and permits of the hub being made a closer fit to the shaft, a point of considerable importance if silent, sweet-running gearing is desired.

FIG. 1. LOVEKIN FLARING TOOL.



ARRANGEMENT OF SHAFT AND SLIDING GEAR.

Tube Expanding and Flaring Tools.

We illustrate herewith a few special tools for expanding and flaring or beveling the inside of small tubes. Fig. 1 shows what is termed the Lovekin flaring tool for flaring the ends of tubes for feed-water heaters, evaporators, distillers, superheaters and boilers. It can be used in the horizontal boring mill and in the drill press, or operated by pneumatic motor, or by hand ratchet, if so desired.

Fig. 2 shows a small tube expander of the modified Dudgeon pattern. These tools are made so that the small rollers have a taper to correspond with the taper of the mandrel, and therefore they roll the tube parallel the entire depth of the tube sheet. They have gages for determining the exact amount of expansion required, so that when once set for a particular piece of work all tubes can be rolled the same amount. This is particularly desirable when rolling the tubes into recesses in the tube plate, as is done in the Lovekin method, which method forms what might properly be called an extruded metal joint to give great holding power and provide against leaky tubes.

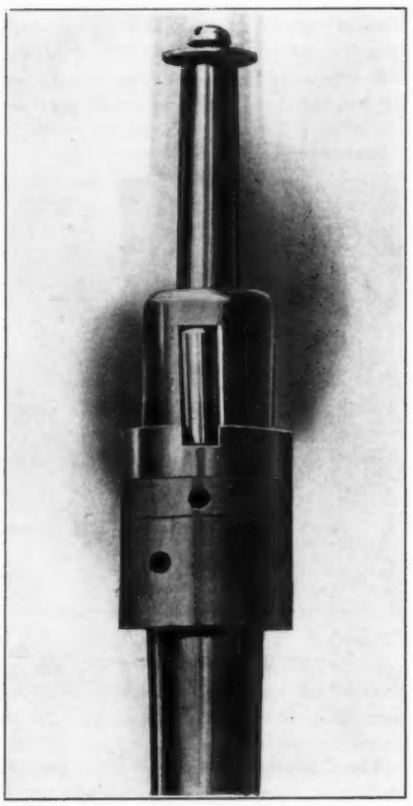


FIG. 2. TUBE EXPANDER.

Fig. 3 shows two different forms of tools for cutting the recesses in the tube sheet or flanges in a satisfactory and expeditious manner. The smaller tool has

been made to recess holes of ½-inch diameter for feed heaters and distillers.

It will be readily understood that in order to make a joint of the type shown in Fig. 4 the first operation is to drill the tube plate, then bevel the ends. After this is done a tool such as shown in Fig. 3 is used to cut the recess inside; then the tubes are inserted and the expanding tool shown in Fig. 2 is inserted; the tube is

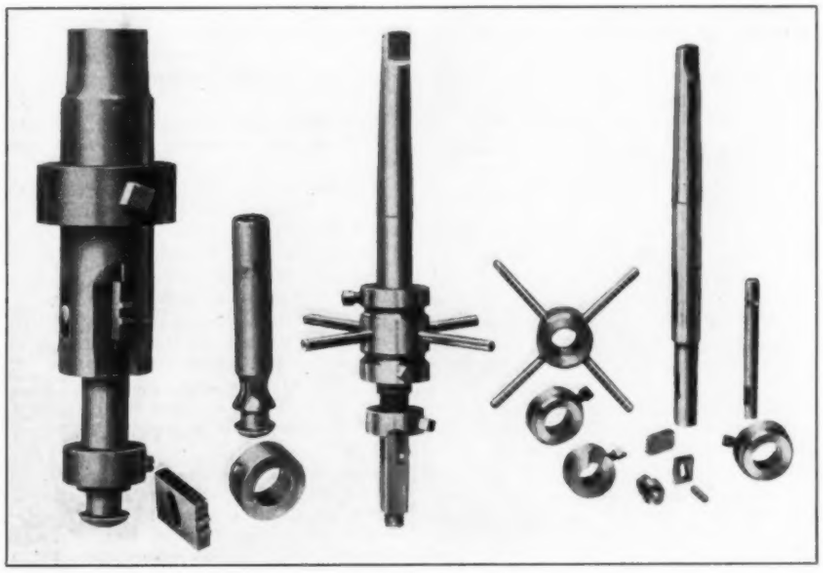


FIG. 3. TOOLS FOR CUTTING RECESSES IN TUBE SHEETS.

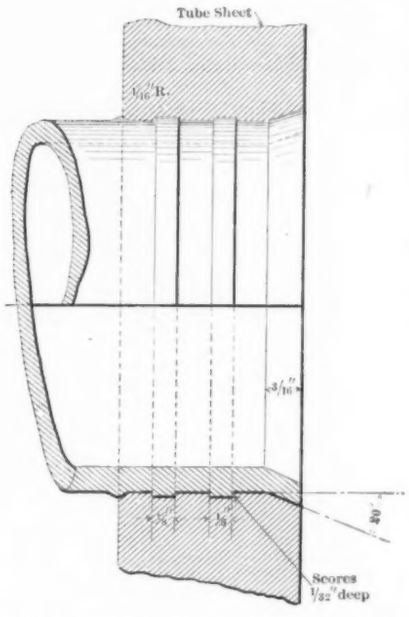


FIG. 4. THE LOVEKIN METHOD OF EXPANDING AND FLARING TUBES.

expanded fully until the recesses in the tube plate are filled up by the process of extrusion. After this is done the tool shown in Fig. 1 is used to bevel or flare the ends of the tube. When finished, the ends are faced off flush with the tube sheet.

These tools are made in sizes from ½ inch to 2 inches by the Lovekin Pipe Expanding and Flanging Machine Company, 421 Chestnut street, and the International Engineering Company, 719 Pennsylvania Building, Philadelphia, Penn.

The Harding Hydraulic Clutch and Speed Variator.

We are in receipt of a pamphlet describing the hydraulic clutch and speed variator invented by John Harding, Jr., Nashville, Tenn. In this invention the two shafts which it connects are in line with one another, with a short distance between their ends, and on one is mounted a cylindrical casing, and on the other a head having four radial slots in which slide vanes. The head and its vanes work inside of the cylindrical casing, the ends of the vanes being guided by an eccentric depression in the inner face of the cylindrical casing, so that they slide in and out radially like the blades in some forms of simple air or water motors. On one side, the cylindrical casing is provided with a butterfly by-pass valve, the opening and closing of which is controlled by a lever connection to a slip collar mounted on the hub of the cylindrical casing. The axis of the valve is parallel to the axis of the shafts. The slip collar, when moved longitudinally by a forked lever, partially rotates because of a helical groove in the hub upon which it is mounted, and this motion operates the valve. When the butterfly valve is wide open there is no opposition to the passage of the oil which fills the cylindrical casing, and the head and vanes are free to revolve within it, and no motion is transmitted. On the other hand, when the butterfly valve is closed no oil can pass by, and the whole thing rotates like one piece, one of the shafts driving the other without any slip. By regulating the amount of opening of the by-pass valve it is plain that the amount of slip can be varied and the speed of the driven shaft made anywhere between zero and 100 per cent. of that of the driver.

The pamphlet contains reports of several different tests of this device. When running at a constant speed of driver of 398 revolutions per minute, a constant torque, and a constant input of 1650 watts, the efficiency when the driven part was running at 100 per cent. of the driver's speed was 82.5 per cent.; at 86.2 per cent. speed the efficiency was 72.6; and at 48 per cent. speed of the driven part the efficiency was 41.1 per cent. It is proposed to use the device as a clutch, such as in a line of shafting in a shop, for hoists and other machinery and on an automobile, and as a transmission and speed variator in the latter cases. The device is in the hands of John T. Landis, care of the Landis Banking Company, corner Third avenue, N. and Union streets, Nashville, Tenn.

Personal.

Angus Sinclair has been appointed "Inspector of Technical Education" of the Erie railroad.

The address is desired of Adolf Bauer, who, it is stated, has gotten up a compound lathe and boring mill. Will anyone knowing the address kindly send it to the editor.

Obituary.

James Dredge, one of the editors and proprietors of *Engineering*, of London, is dead. He had been in ill health for some time. Mr. Dredge was well known in engineering circles of America and was a Royal Commissioner to our Centennial and Chicago exhibitions. With Mr. Maw he built up *Engineering* into a great journal and its pages have always been pervaded by a spirit of fairness and good fellowship for all the world. Willingness to accept and advise the acceptance of new ideas, freedom in pointing out directions in which improvements might be made in the practice of his own countrymen and a general broadmindedness have characterized the journal, which, though not due solely to Mr. Dredge, could not have obtained to such an extent, had he not been in hearty sympathy with such ideas, as in fact he was known to be.

Daniel Baird Wesson, of the firm of Smith & Wesson, died at his home in Springfield, Mass., August 4, after an illness of almost four years. Mr. Wesson was born in Worcester, Mass., in 1825, and learned the gunsmith's trade under his brother Edwin at Northborough. In 1853 he formed a partnership with Horace Smith, of Norwich, Conn., and there worked out the principles of the Winchester rifle. He first put into use the self-primed metallic cartridge, used during the Civil war. About this time Mr. Wesson succeeded in perfecting a revolver the principal feature of which was

that the chambers ran entirely through the cylinder. Mr. Wesson and Mr. Smith in 1866 built a factory at Springfield employing 600 men. During the Civil war they supplied the Government with firearms. Mr. Wesson was also the inventor of several other improvements, the most important of which were the automatic cartridge-shell extractor and the self-lubricating cartridge. He also introduced the hammerless safety revolver. He was president of the Cheney-Bigelow Wire Works and a founder of the First National Bank of Springfield.

Business Items.

The Lapointe Machine Tool Company, of Boston, Mass., is now erecting a factory at Hudson, Mass., and expects to move its plant about Sept. 15. The building is of brick construction, 40x150 feet, two stories; two ells, utilized for office and stock room. This factory will be equipped with many additional new tools.

The Estacada Brick and Tile Company, Estacada, Oregon, intends starting a machine shop and is in the market for lathes and drills.

Manufacturers.

The Gate City Malt Company, Omaha, Neb., will erect a new plant.

The Waterloo (Iowa) Rope Belt Company is erecting a new plant.

The Tampa (Fla.) Electric Company will erect a large new power house.

The McDonald Gas Meter Company, Albany, N. Y., will erect a new factory.

The National Pipe Bending Company, New Haven, Conn., will build an addition.

The Moosup (Conn.) Thread Manufacturing Company will build a two-story addition.

A two-story boiler house will be erected for Hirst, Roger & Co., Philadelphia, Pa.

The Union Typewriter Company, Bridgeport, Conn., is erecting a four-story addition.

The Maryland Roofing and Manufacturing Company, Baltimore, Md., will enlarge its factory.

The American Seeding Machine Company, Springfield, Ohio, will erect a new blacksmith shop.

The Beaver Dam (Wis.) Malleable Iron Company is making extensive additions to its plant.

The Reeves Threshing Machine Company, Oklahoma, O. T., will build a new $40,000 plant.

Jenkins Brothers, manufacturers of valves, New York, will erect a plant in Montreal, Canada.

The American Confectionery Company, Nashville, Tenn., will erect a new $100,000 factory.

The Hartford (Conn.) Manufacturing Company, envelope makers, will erect a five-story addition.

The Waterbury (Conn.) Brass Company will put up a new building to be used as a rod mill.

The Ideal Coated Paper Company, Brookfield, Mass., will put up an addition four stories high.

J. W. Myers, P. O. Box 326, Buena Vista, Va., contemplates establishing an ice-manufacturing plant.

John W. Masury & Son, Brooklyn, N. Y., paint manufacturers, will erect a large plant in Elizabeth, N. J.

The Orford Copper Company, Constable Hook, Bayonne, N. J., will add three new buildings to its plant.

A $30,000 building will be erected for the Sherwin-Williams Company, Boston, Mass., paint and varnish manufacturers.

The Norfolk (Va.) & Portsmouth Traction Company has awarded contract for the construction of its new power-house.

Greaves, Klusman & Company, builders of woodworking machinery, Cincinnati, Ohio, are planning an addition to cost $6000.

A new cold storage building will be added to the plant of the Merchants' Freezing and Cold Storage Company, Providence, R. I.

The Jewett Typewriter Company, Des Moines, Iowa, has purchased a factory building, which will be enlarged and remodeled.

The Coulter & McKenzie Machine Company, Bridgeport, Conn., has awarded contract for the construction of a one-story factory building.

Contracts are being awarded for the erection of a new plant for McDonald & Company, Albany, N. Y., manufacturers of gas meters.

The W. F. Safford Manufacturing Company, Portland, Me., builders of motor boats and gasolene motor engines, will move to Westerly, R. I.

A power-house to cost about $16,000 will be erected at Wilmington, Del., for the Philadelphia, Baltimore & Washington Railroad Company.

The Steel & Johnson Manufacturing Company, Waterbury, Conn., making buttons and small brass goods, will build an addition, four stories high.

The plant of the United States Leather Company, at Prentice, Wis., was almost totally destroyed by fire, causing a loss of over $300,000.

The Waterbury Farrel and Machine Company, Waterbury, Conn., has purchased all the stock of the Waterbury Machine Company and now owns same.

The Connecticut Railway and Lighting Company will enlarge its power plant at Bridgeport, Conn., and will also erect a new car-repair shop at Waterbury.

Wilcox, Crittenden & Company, Middletown, Conn., making marine hardware, will erect an additional factory, to be used as a machine shop, grinding room, etc.

The Peck, Stow & Wilcox Company, Southington, Conn., manufacturers of hardware, will erect another addition. A new blacksmith shop is also contemplated.

Ed. Nealy, of Red Lake Falls, Minn., who recently secured the franchise for lighting and power at Grand Forks, N. D., will soon start work on the power plant.

Plans for the construction of a $500,000 power plant for the Latrobe branch of the Railway Steel Springs Company, of New York and Chicago, are being prepared.

The S. S. Severance Spike and Rivet Company, Glassport, Pa., will put up a new mill adjoining the one recently erected and which replaced the one destroyed by fire.

The Peter McFarlane & Sons Iron Works Company has been incorporated at Denver, Colo. Capital, $50,000; incorporators, John Rasmussen, of Denver, and others.

Edwin F. Ohl, Edwin F. Norris, of New Castle, Penn., and others have organized the Lawrence Cement Company, which will erect a plant at a cost of over $1,000,000.

The Detroit (Mich.) Insulated Wire Company, a subsidiary concern of the Westinghouse Electric and Manufacturing Company, has been formed. A large plant will be erected.

The Lawndale (Cal.) Manufacturing Company has been incorporated, with a capital of $50,000 to make washing machines, patent dump wagons, etc. D. T. Davenport, C. B. Hopper, F. B. Hopper and others, of Los Angeles, incorporators.

The factory, machinery and tools formerly owned by B. A. Ballou and the Mechanical Accountant Company, Providence, R. I., have been purchased by George F. Rooke, of that city, who will operate under the name of the Providence Manufacturing and Tool Company and will engage in a general machinist business, besides manufacturing adding machines. The factory will be enlarged.

Trade Catalogs.

Kendrick & Davis, Lebanon, N. H. Circular illustrating and describing steel rules with handles.

Fort Wayne Electric Works, Fort Wayne, Indiana. Bulletin No. 1081, descriptive of type A transformer.

Oswego Machine Works, Oswego, N. Y. Artistically printed circular descriptive of the paper-cutting machines made by this firm.

Empire Machine Company, Pittsburg, Pa. Pamphlet describing the Empire tachometer. Illustrated, 3½x6 inches, 8 pages, paper.

Joseph Dixon Crucible Company, Jersey City, N. J. Booklet describing graphite brushes. Illustrated, 11 pages, 3½x6 inches, paper.

Windsor Machine Company, Windsor, Vt. Catalog describing the Gridley automatic turret lathe. Illustrated, 6x9 inches, 47 pages, paper.

The American Ferrofix Brazing Co., Arcade Bldg., Philadelphia, Pa. Circular describing ferrofix and showing castings repaired by this process.

C. W. Hunt Co., West New Brighton, S. I. Pamphlet No. 064, describing "Industrial" railways. Illustrated, 3½x6 inches, 44 pages, paper.

Saranac Machine Company, St. Joseph, Michigan. Pamphlet descriptive of the basket and crate-making machines manufactured by this company.

Wellman-Seaver-Morgan Co., Cleveland, O. Circular No. Ho-7, describing high-grade geared hoisting engines. Illustrated, 6x9 inches, 32 pages, paper.

The Bristol Co., Waterbury, Conn. Bulletin No. 41, describing briefly different types of recording instruments. Illustrated, 3x6 inches, 12 pages, paper.

Lippincott Steam Specialty and Supply Co., Newark, N. J. Catalog of engine indicators, reducing wheels and planimeters. Illustrated, 6x9 inches, 24 pages, paper.

Crocker-Wheeler Company, Ampere, N. J. Bulletin No. 66 illustrating and describing type W motors for rolling-mill service. 8 pages, 7½x10 inches, paper.

The Cincinnati Punch & Shear Company, Cincinnati, Ohio. Catalog of power punching and shearing machinery, rolls, etc. Illustrated, 55 pages, 6x9 inches, paper.

The Rollins Engine Company, 29 Mason street, Nashua, N. H. Bulletin No. 15, describing model No. 2 Rollins engine. Illustrated, 23 pages, 6x9 inches, paper.

The Pittsburg Automatic Vise and Tool Co., Pittsburg, Pa. Catalog No. 50, describing the Long patent double and single swivel vises. Illustrated, 4x6½ inches, 16 pages, paper.

Athol Machine Company, Athol, Mass. Catalog No. 30, describing vises, machinists' tools, grindstone frames and other specialties. Illustrated, 80 pages, 5x7 inches, paper.

Hanna Engineering Works, Chicago, Ill. Catalog No. 3, second edition, 1906, describing different kinds of riveters made by this com-

pany. Illustrated, 6x9 inches, 34 pages, paper.

The Western Tool and Manufacturing Company, Springfield, Ohio. Catalog and price list of their various products, including expanding mandrels, reamers, tool stands, surfacing tools, etc.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Runnerless slide rules. F. F. Nickel, 27 Winans street, East Orange, N. J.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs. Parsons & Lane, Sodus, N. Y.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

Wanted — One Cleveland automatic screw machine with spindle capacity of from one to two inches, 1-inch size preferred; must be present style construction and in good order. Give serial number, price and full particulars. L. C. Smith & Bros. Typewriter Co., Syracuse, N. Y.

The University of Cincinnati has a few positions to offer energetic young men who desire to take an engineering course while supporting themselves in large measure by working as apprentices in the machine plants of Cincinnati. For information apply to Secretary, University of Cincinnati, Cincinnati, O.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Proposals will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 10 o'clock a.m., August 28, 1906, and publicly opened immediately thereafter, to furnish at the navy yard, New York, N. Y., a quantity of machine tools, as follows: Sch. 51: Shaper, bending machines, blower. Sch 52: Steam hammer, blower, lathe. Applications for proposals should designate the schedules desired by number. Blank proposals will be furnished upon application to the navy pay office, New York, N. Y., or to the Bureau. H. T. B. Harris, Paymaster-General, U. S. N. 7-11-06

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Going machine shop, situated in northern Ohio; natural gas; will bear strict investigation; good reason for selling. Address Box 525, Tiffin, Ohio.

For Sale—One 50-h.p. gasolene engine, used only a few months and good as new; also one 25 h.p. Address Detroit Engineering Works, Chene and Guoin streets, Detroit, Mich.

Business Opportunities.

Wanted—Capital to start manufacturing patented cutter and reamer. This is a money and labor-saving tool, something which will sell on sight. Would consider proposition of a firm desiring to add new line of manufacturing. Address Box 926, AMER. MACHINIST.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

A designer and manufacturer of large experience and national reputation would like to associate with a person or persons having capital and wishing to engage in a promising business. Address Box 930, AMER. MACH.

Superintendent of an extensive manufacturing plant desires to make a change; accustomed to the latest and best machine-shop methods and practice; capable of organizing and handling a machinery plant in all its branches; a designer of special and automatic machinery, tools, jigs and fixtures for the rapid and economical production of fine and medium heavy interchangeable work. Box 950, AMERICAN MACHINIST.

ILLINOIS.

Assistant superintendent or superintendent for smaller concern by foreman; W. & M. patternmaker; 15 years' experience with largest concerns; specialty, farming implements, moulding and special machinery. Box 934, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Position where inventive mechanical ability is required. I am 34, single, technical graduate, with 14 years' shop and drafting experience. Box 927, AMER. MACHINIST.

MISSOURI.

Position wanted as master mechanic, superintendent or general foreman; owned and operated a good machine shop and foundry for 15 years; age 39; health and habits good. Address J., Room 24, Ricksecker building, Kansas City, Mo.

NEW JERSEY.

Accountant, auditor, office manager, of executive ability, desires permanent engagement; 15 years with large manufacturing corporation, several years public-accounting; experienced in centralizing, organizing, installing labor-saving and result-producing methods; full comprehension cost accounts, capable to direct large force and handle details. Accountant, Box 941, AMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman, 23, wants to change position; good detailer and some knowledge of designing; location New York City. Box 931, AMERICAN MACHINIST.

Machine-shop foreman desires change; experienced on electrical machinery and automatic electrical apparatus; also understands erection of power plants. Box 935, AM. M.

OHIO.

Wanted—To correspond with concerns wanting representative in Cincinnati and vicinity. Box 936, AMERICAN MACHINIST.

PENNSYLVANIA.

Patternmaker foreman would like to make a change; young man, 14 years' experience; six years foreman with present firm; best of reference. Box 932, AMERICAN MACHINIST.

Pattern-shop foreman wishes position; practical and experienced; thoroughly familiar with intricate core work and modern foundry practices; 7 years in charge at last place; best of references. G. A. J., Box 942, AMER. MACH.

WISCONSIN.

Machine-tool draftsman with experience at designing; technical, practical and thoroughly reliable. Address R. D. J., Box 952, AM. M.

Designer, with extensive experience on special machine tools and automatic machines for manufacturing; having shop experience, technical education, and familiar with equipment for steam engines, steam turbines and electric machinery. Box 951, AMER. MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

We are increasing our tool department and invite applications from toolmakers experienced on fixtures, dies and gages. Address, with full particulars as to experience and wages required, Ross Rifle Company, Quebec.

CONNECTICUT.

Wanted—A first-class blacksmith on heavy machine forging. Address, stating experience and salary required, Farrel Foundry and Machine Co., Ansonia, Conn.

A new concern manufacturing electrical specialties, including fuses, cutouts and similar appliances, requires a man to take charge of factory; must be experienced in designing and making dies, tools, jigs, etc., and be able to handle help and devise methods for economical production; to the right man we are ready to pay the right price. Address Box 24, Station A, Hartford, Conn.

ILLINOIS.

Wanted — Three or four machinists, one with outside experience; chance for good men to advance. Box 933, AMERICAN MACHINIST.

Wanted—Young mechanical draftsmen, two to four years out of college and experienced in complicated mechanism. Box 949, AM. M.

Wanted — Detail draftsman on high-grade moderately heavy work; prefer Swedish technical graduate; state experience, married or single, and pay expected; steady place for good man. Box 908, AMERICAN MACHINIST.

Wanted—Foreman of experience for manufacturing small, intricate, interchangeable parts; must have executive ability and be able to make machinery and operators work at maximum efficiency; write fully, giving age, experience and wages wanted. Address Box 948, AMERICAN MACHINIST.

Wanted—An experienced factory superintendent for the manufacture of a variety of metal specialties; man must be of good character, reliable, painstaking, mentally alert, and a thorough master of detail. The factory is new and well equipped. Salary $2000 per year, but superintendent must make cash investment of $3000 and contract for three years. Box 871, AMERICAN MACHINIS.

MAINE.

Wanted—A working foreman for a brass foundry; one who is well acquainted with the mixing, molding and finishing of brass castings. Reply, stating experience, with references, to Box 939, AMERICAN MACHINIST.

MARYLAND.

Wanted—Toolmakers on automobile work. Address "P," Box 937, AMERICAN MACHINIST.

Wanted—A man to act as master mechanic and to superintend the designing of all tools and fixtures for the interchangeable and economical manufacture of large quantities of automobiles; steady position to right man with one of the largest automobile manufacturers. Box 909, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Young man familiar with machine tools, graduate of some technical school, to take charge of our catalog and circular department. Hill, Clarke & Co., 156 Oliver St., Boston, Mass.

A practical machinist, capable of handling fine and accurate work, or, if necessary, getting out the ordinary class of work in money-making time. There is a field in special machinery and the advertiser has shop with established business along this line, which can be increased with profit. To the right man with large experience an interest with charge of the shop is offered. Investment of about $5000 would be advantageous. I am not looking so much for the capital as the man. In answering, state what your experience has been, to insure answer. Address Box 894, AM. M.

MICHIGAN.

Wanted — Experienced mechanical draftsman by a large concern building railway supplies; must be able to do detail designing in a practical manner; man familiar with both structural steel and light car work preferred; permanent employment to right party; references required. Address Car Builder, Box 912, AMERICAN MACHINIST.

Wanted—Our annual vacation comes between the dates of Aug. 11 and 27; immediately after this time we will need a number of first-class toolmakers. We want only men who have had experience on accurate tools, jigs and fixtures for interchangeable machinery, and to such we can offer steady work at good wages. Box 911, AMERICAN MACHINIST.

MINNESOTA.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

MISSOURI.

Instrument assemblers wanted—Four experienced instrument assemblers; permanent to good men. Apply in writing, stating experience and wages desired. Wagner Electric Mfg. Co., St. Louis, Mo.

Wanted—Designing draftsman, one who has had a wide range of experience on large gas engines and producer plants; in writing, give full details as to previous and present records, salary expected, also when position can be accepted. Address Box 910, AMER. MACHINIST.

NEW HAMPSHIRE.

Wanted—A thoroughly reliable and hustling master mechanic or shop foreman who can handle 100 or more good American workmen to best advantage and get out a good production; must be competent designer of tools and jigs for making in duplicate medium automatic machinery accurately and cheaply; conversant with up-to-date machine-shop methods and organization. Address, giving experience, references and salary expected, Box 878, AMERICAN MACHINIST.

NEW JERSEY.

Wanted—Machinists to build brass instruments; good wages to right men. Address 278 Ridgwood avenue, Ridgewood, N. J.

Draftsmen—Practical men on general engineering work for plant 25 miles from New York; state age, experience and salary. Box 940, AMERICAN MACHINIST.

Diesinkers and tool and diemakers wanted; steady work near New York to right men; state experience and salary expected. Address Machinery, Box 947, AMER. MACHINIST.

Wanted—Lathe, planer, drill, boring mill and floor hands, also apprentice hands of two or three years' experience; good wages; open shop. Krom Machine Works, Plainfield, N. J.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chase Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Wanted—Foreman diemaker to operate a small automatic hardware plant. Box 920, AMERICAN MACHINIST.

Toolmakers with experience on fine, accurate die work wanted, New York City. Jones Speedometer Co., 127 West 32d street.

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Draftsmen on jigs, fixtures and tools wanted; experienced men only. Mergenthaler Linotype Co., 20-42 Ryerson street, Brooklyn, N. Y.

Wanted—By a large manufacturing concern, several detail draftsmen and tracers on machine and tool work. Write, giving age and experience, F. G. H., Box 916, AMER. MACH.

Wanted—Two or three good toolmakers experienced on tools for sheet metal, stamping, drawing and knurling. In replying, state experience and wages expected. Rome Manufacturing Co., Rome, N. Y.

Assistant to superintendent in machine shop for electrical appliances; must be energetic and experienced in handling men; give experience, references and salary required. A. B. C., Box 944, AMERICAN MACHINIST.

Draftsmen wanted on details of light wood and steel construction work; accuracy in dimensions essential; good jobs for good men; state age, experience and salary expected. Address Box 899, AMERICAN MACHINIST.

Wanted—First class all-around machinist, one familiar making and designing tools to increase production preferred; state wages, experience, etc.; good opportunity for right man. Address Box 953, AMERICAN MACH.

Superintendent wanted for operating drills in open-cut tunnel; must have mechanical experience and ability to handle men and machinery; in applying, state full particulars as to age, nationality, previous employers, salary expected and when available. Address S. & B., Box 945, AMERICAN MACHINIST.

Wanted—Foundry foreman for gray-iron foundry in central part of New York State employing about 50 men and making a great variety of work; must be a man of fair education, good executive ability and up to date in modern foundry practice; salary $2000. Address G. I., Box 906, AMERICAN MACHINIST.

Wanted—A master mechanic by a large manufacturing concern; must thoroughly understand engines, boilers, dynamos, motors, piping, millwright and carpenter work; must have good executive ability and be able to take charge of entire up-keep of plant; give detailed experience, age, salary expected and references. Box 943, AMERICAN MACHINIST.

OHIO.

Wanted—By the Bickford Drill and Tool Company, Cincinnati, O., experienced toolmakers, vise and scraper hands.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Wanted — Competent toolmakers familiar with fine work on small punches, dies and **small jig work**; permanent position with good pay under best of conditions. Box 925, AMERICAN MACHINIST.

Wanted—Young man familiar with details of heavy engine construction and manufacturing costs as assistant in sales department; technical graduate with business experience preferred. Address Box 946, AMER. MACH.

Wanted—A thoroughly up-to-date machinist, one who understands his business and can handle men as foreman; prefer a man with from $1000 to $3000 to take stock in the company; position open Sept. 1. Address Box 903, AMERICAN MACHINIST.

Wanted—Three first-class draftsmen familiar with the design and construction of electric traveling cranes; also one structural draftsman; permanent position and good wages guaranteed; only experienced men need apply. Address Case Mfg. Co., Columbus, O.

PENNSYLVANIA.

Wanted—First-class machinists and toolmakers; good wages to right parties; no labor troubles. Box 857, AMERICAN MACHINIST.

Wanted — Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Six high-class tool and diemakers; permanent positions at best wages; write for particulars, stating experience. The Adder Machine Co., Wilkesbarre, Pa.

Wanted—Draftsman with shop and drawing-room experience, one with paper-machine experience preferred; state qualifications, age and salary expected. Box 915, AMER. MACH.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

VERMONT.

Wanted—A young draftsman with some experience on textile machinery; one who has also worked in machine shop preferred. Box 938, AMERICAN MACHINIST.

VIRGINIA.

Wanted—An instructor in industrial free-hand drawing, mechanical drawing and elementary mathematics; the man for this position must be particularly strong on free-hand drawing; salary $900 first year; applicants will please enclose testimonials. Apply to W. H. Rasche, Blacksburg, Virginia.

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., Milwaukee, needs more patternmakers, machinists and moulders.

Machinist to construct special iron-working tools; good wages and steady work to the right man. Address Thomas B. Jeffery & Company, Kenosha, Wis. (Rambler automobiles). Kenosha is 52 miles north of Chicago.

Wanted—A few first-class machinists, toolmakers and patternmakers; shop one of the best in the country and equipped throughout with the highest grade of tools; city one of the best in the country; educational facilities of the best; pure water, etc.; only steady, reliable men looking for permanent positions need apply. Address Box 848, AMER. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., is constantly increasing its works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

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The Tabor Hinged Molding Machine.

EDITORIAL CORRESPONDENCE.

The readers of the AMERICAN MACHINIST are well aware of the rapid advances made during recent years in molding machines. The machine shown in the accompanying illustrations is the most recent development of the Tabor Manufacturing Company, of Philadelphia, and is intended largely to occupy a field to which molding machines have not heretofore been applied, this field being the molding of patterns which, by reason of their size or the limited number of castings required from them, have not heretofore been molded on machines. In addition, however, to occupying a new field its method of operation is such as to introduce advantages not possessed by power machines.

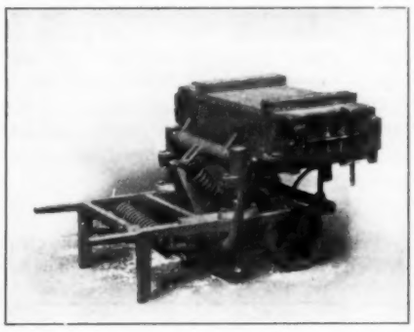

FIG. 4. DRAG COMPLETE READY TO TURN OVER.

FIG. 3. RAMMING THE DRAG.

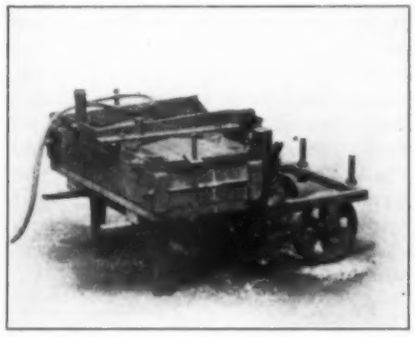

FIG. 5. DRAG TURNED OVER.

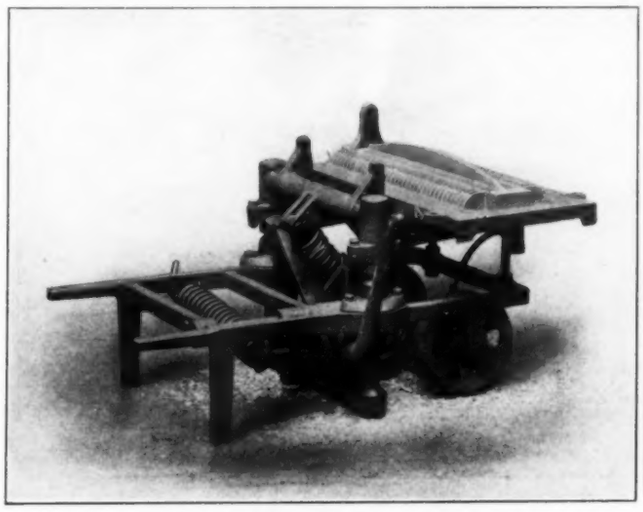

FIG. 1. READY TO BEGIN OPERATIONS.

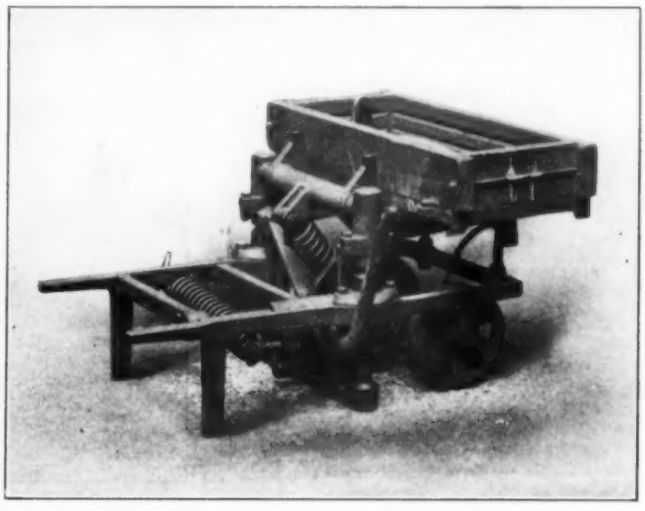

FIG. 2. DRAG PART OF FLASK IN POSITION.

A glance at the illustrations will show that the machine might be called a wheelbarrow machine, as by reason of its wheels and handles it is readily portable. It is intended that it shall follow up the pile of sand, as the latter is consumed, the completed molds being left on the floor behind it, precisely as in hand molding. This feature is of importance because of the size of the work to which the machine is adapted, inasmuch as such work consumes a good deal of sand, the taking of which to a stationary machine as well as the distributing of the completed molds therefrom would involve considerable labor.

OPERATION OF THE MACHINE.

Figs. 1 to 8 inclusive show the complete operation of the machine in connection with flat-back work, in which the mold is entirely in the drag, the cope surface being flush with the flask. Fig. 1 shows the mold board with its attached pattern, —in this case a grate bar—ready for the application of the drag flask as shown in Fig. 2. Fig. 3 shows the drag filled and in process of ramming, and Fig. 4 shows it complete with its bottom board attached, the mold board, drag and bottom being clamped together as shown. This operation complete, the entire structure is turned over as shown in Fig. 5, the diagonal balance spring, which is adjustable for any weight of flask, enabling this operation to be done with very little exertion on the part of the molder.

Fig. 5 shows attached to the swinging frame of the machine the pneumatic vibrator, with which all users of molding machines are familiar. The clamps being removed, the vibrator is started, and the handle at the front of the machine is pushed down, by which the mold board and pattern are bodily raised in a truly vertical direction as shown in Fig. 6, after which the mold board is turned back as shown in Fig. 7, and then dropped to its original position, the lever being again raised as shown in Fig. 8, the drag part of the mold being now complete. The drawing of the pattern, it should be observed, is facilitated by the horizontal spring shown in Figs. 1 to 4 which, like the turnover spring, is adjustable for any weight.

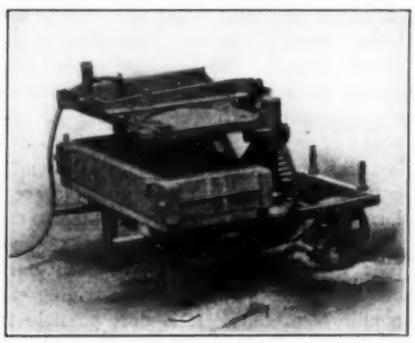

FIG. 6. PATTERN DRAWN.

THE OPERATION CONTRASTED WITH THAT OF POWER RAMMING MACHINES.

It will be seen that the procedure is es-

sentially that of hand molding, the drag being rammed while bottom side up, and then turned over in order to draw the pattern. Contrasting the operation with that of power-ramming machines, in which the pattern is drawn downward instead of upward, it will be seen that the mold is in the most favorable position as regards the gravity of the sand to avoid the disturbance of any of its delicate parts by the drawing of the pattern, the result being that the necessity for the use of gaggers is entirely obviated. In this respect, indeed, the machine is superior to hand work, the operation of the vibrator on delicate parts of the machine being much less severe than hand rapping of the pattern. It is not necessary, however, that the vibrator should be used on all classes of work, and in fact the machines are installed in many foundries where no compressed air is available. It is simply necessary on delicate work, that care should be exercised to free the sand from every part of the pattern before the pattern-drawing movement begins, and this can be done best by the use of a vibrator on the back of the hinged frame; but in many classes of work a mallet is quite as efficient, though not so convenient as a vibrator.

FIG. 7. TURNING OVER THE PATTERN.

Comparing the operation with that of power-ramming machines again, it will be seen that the pattern being drawn upward, the need of stripping plates is entirely avoided—a fact which at once makes feasible the application of the machine to many pieces of limited production in connection with which the cost of stripping plates would be prohibitive. In the case of flat-back work there is, in fact, no need of special mold boards for the various patterns, since with this class of work there is no necessity for exact matching of cope and drag, and it is a common practice with such work to store the patterns in their ordinary condition and attach them to mold boards, as occasion arises. It so happens that in the case shown, the pattern is prepared for extensive operations, and the mold board is of iron. In common practice, however, the mold board is of wood, as shown in the various examples of Fig. 10.

CHANGING THE MOLD BOARDS.

One feature of the machine by which the changing of mold boards is greatly facilitated, is not fully shown in the illustrations, because of the iron mold board used in connection with the job illustrated.

FIG. 8. DRAG COMPLETE READY TO BE SET ON FLOOR.

FIG. 9. EXAMPLE OF SPLIT MOLDING.

It will be observed that the hinged frame to which the mold board is attached has holes drilled through it, by which the board is bolted to it. The bolts are turned and fill the holes and thus act the part of dowels to insure exact replacement of the board at any time. In the case of wooden boards, they are fitted with dowels which enter these holes, and thus insure correct location in addition to which the boards have upon their backs iron clamps or buttons, with suitable bolts by which they are clamped in position with but a trifling expenditure of time. It is thus possible to mold from a variety of patterns, as shown in Fig. 10, almost as quickly as from the same pattern, the time of changing being practicably negligible.

PRINTING BACK.

It will be observed at once that the provision of positive guides for drawing the pattern enables it to be replaced in the mold if need be, a feature which is made use of in work requiring the use of facing, the pattern being printed back after the application of the facing, thus avoiding entirely the use of the trowel in finishing the mold. This positive guide for the pattern is also made use of in cases where the delicate parts of the mold have been broken in drawing the pattern. In such cases it is only necessary to remove the loose sand, pack additional sand in the portions of the pattern for the broken part of the mold, replace the pattern in the mold, and draw it as before. As has been said, however, the breaking of the mold, when drawing the pattern, is much less apt to happen than with hand work, and in fact one of the leading advantages of the machine over hand work lies in the fact that slicking and finishing are almost entirely obviated.

THE USE OF SPLIT PATTERNS.

When using the machine in connection with patterns which must be molded partly in the drag and partly in the cope, the common arrangement used with the split pattern power machine is followed—the two halves of the pattern being attached to the same mold board from which both drag and cope are molded, and then placed together in the reversed position from that in which they were molded, thus casting two pieces at once, one right side and the other bottom side up.

This use of the machine is shown in Fig. 9, the mold board being shown with two halves of the pattern attached to it. It so happens that in this case the two sides of the pattern are so nearly alike that they might be taken for duplicates,

and intended for flat-back work. Careful examination will, however, show that the two sides are not alike, one being, in fact, the bottom of the other. In this use of the machine the drags are first rammed up, and then the copes, the copes being turned end for end when the molds are closed. In this class of work it is not feasible to entirely avoid the use of gaggers in the cope. So far as drawing the pattern is concerned, there is no more need of them than in the drag; but to avoid danger of dropping the delicate parts when the molds are closed, gaggers are used in connection with such parts in the cope.

In cases in which the size of the patterns is such as to make it impracticable to have two molds in the same flask, the two halves of the pattern are attached to separate mold boards, the copes and drags being commonly made on separate machines, and the molds closed as they are completed; or in case a single machine only is available, the entire lot of drags is made first, which are then followed by the copes and the molds closed one by one as the copes are molded.

Fig. 10 shows a variety of patterns arranged for molding on the machine. At the extreme right and in the foreground are two grate bars, and in the left foreground is a collection of pieces, all of which are flat-back work. The remaining pieces in the background are all split pattern work arranged for molding in drag and cope alternately, in the manner which has been described. F. A. H.

FIG. 10. A VARIETY OF PATTERNS ARRANGED FOR THE MACHINE.

The commencement of the movement of trains by electricity between Camden and Atlantic City, on the Pennsylvania Railroad, has been postponed until the close of the heavy summer travel. It is probable that it will occur about the middle of September.

How the Construction of a Pattern may be Improved by Getting the Molder's Ideas upon It.

BY J. WILSON.

In traveling among the foundrymen and foundries of the country, I have discovered that it is the practice among the majority of them to allow the wood-pattern maker to design how the different patterns ought to be molded, which practice is probably due to the fact that the pattern maker is usually a better educated man than the molder and has therefore the greater influence over the proprietor; his trade requires that he shall be able to read blue-prints, to lay out work, and to plan ahead, and he must also have a knowledge of molding and core-making, as well as of machinery; on the other hand the molder's trade is to take the pattern that the pattern maker makes and mold it in the sand, vent it, set in the core, close and pour, and his practice makes him skilled in such points as patching and slicking the green-sand surface of the mold where it has been torn up by the drawing-out of the pattern and the setting in of the cores. In such points the molder excels the pattern maker. A similar knowledge is required by the boss molder, together with a familiarity with the mixing of the metal and running of the cupola, and his position permits him to obtain a broad knowledge of the foundry in all its branches, even bringing him into the pattern shop. If he is at all bright, he is in a better position to say how a pattern should be made than the pattern maker, and a wise pattern maker will seek the friendship and knowledge of the boss molder. The pattern maker in a jobbing pattern shop does not have this advantage, since there is no boss molder around the shop to consult, and he is thus compelled to rely upon his own judgment, the result of which is, that he often constructs his pattern in the way which will be best for him to get a profit out of it without making too large a bill against the owner of the pattern and prejudicing his chances of getting future work from that source. When completed, the pattern is well shellacked and sand-papered, the prints made one color and the pattern proper another; the job is a showy one and generally makes a good impression, it is then sent to the foundry and the trouble begins. The first thing the foundryman finds is that before he can start molding, he has got to make a flask and set bars in it. No matter what the cost is, he sends his bill in accordingly, and if the party who owns the pattern is not satisfied he can try some other foundryman, and this usually leads him to discover that

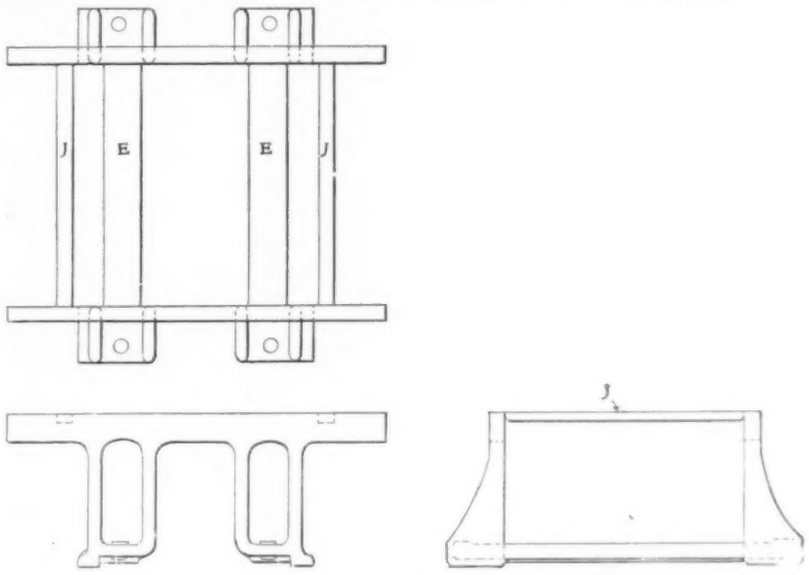

FIG. 1. THE CASTING TO BE MADE.

the pattern maker's job, although nice-looking, was not profitable to his own pocketbook, and often causes him to change his pattern maker.

A JOB WHICH HAD TO BE DONE OVER.

To illustrate the foregoing observations, I have selected a job which I had the privilege of seeing worked in a foundry, and which had to be made over in another way before it was right, and acceptable to the foundryman and the owner of the pattern, this particular job being only one of many that have come to my attention, some of which were made by jobbing pattern makers and others made right in the foundry pattern shop, the cause for the mistakes in the latter cases being that the boss pattern maker considered that he knew more than any molder and would not think of consulting the boss molder; and his influence with the proprietor, in accordance with the circumstances stated at the beginning, gave him the opportunity of going ahead his way, even if the boss did have to pay more to have the job molded.

Fig. 1 shows the casting required to be made, which is a large machine frame; when made as it should be it requires a flask about 30x30 inches, but it was first made in a three-parted flask 20x30 inches with the cheek all barred up. This three-parted job is shown in Figs. 2 and 3. Fig. 2 is a vertical section showing the drag, cheek and cope, with the pattern setting in its place, while Fig. 3 is a plan of the cheek section. The manner in which the pattern was constructed will be noticed; the casting proper being such a light frame of iron, it became necessary to brace up the pattern with stop-off pieces as shown in Fig. 2. The pattern was made in two sections, held in the correct location by dowel pins.

MOLDING AS A THREE-PART JOB.

The job when made in a jobbing foundry is set up in the sand drag section down, bedded into the sand to the parting line of the drag and cheek, and the cheek is set around the pattern in the desired position, the heap sand being then filled in all around the pattern and rammed. Parting sand is then put on, the cope is set in place and rammed up, the cheek and the cope sections are then rolled over and set on a board, then the top of the cheek is made perfect and slicked off, and parting sand is put on, then the drag is set in place and rammed up; is lifted off, leaving the pattern in the cheek, then the cheek half of the pattern is drawn out of the cheek, and the drag is set on the cheek again. The whole affair is then turned over with the drag section resting on a board, then the cope section is removed, and the remaining section of the pattern in the cheek is drawn out and the cope set back on again. All pouring holes and risers are set in place. One of the bad points with this method is that the two sections of the pattern in the cheek will separate when the mold is turned over the first time, and when the mold is completely over and an attempt is made to shove the pattern back into its place, it will not go back, as sand has scraped off the sides of the mold surrounding the doweled feet of the pattern, and fallen down between the joints of the two half patterns; this will not be noticed by the molder, but when the casting comes out and is measured it will be found to be wider than the pattern, with the result that this particular casting is too wide for the place where it is to go. The construction or shape of the casting makes it impossible to put clamping irons in it to hold it together while it is being turned over, and even if clamping irons could be put in the pattern the jobbing shop would charge more for making it in a three-parted flask than they would for making it in a two-parted one; furthermore, in the latter case the job could be molded by a molder of less skill, and the making of a three-parted flask could be dispensed with.

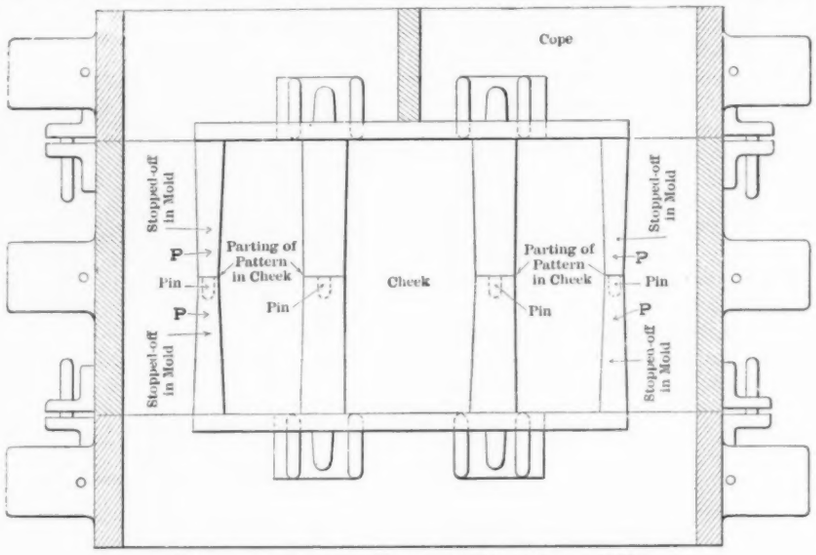

FIG. 2. Vertical Section of Three-part Mold with Pattern in Place.

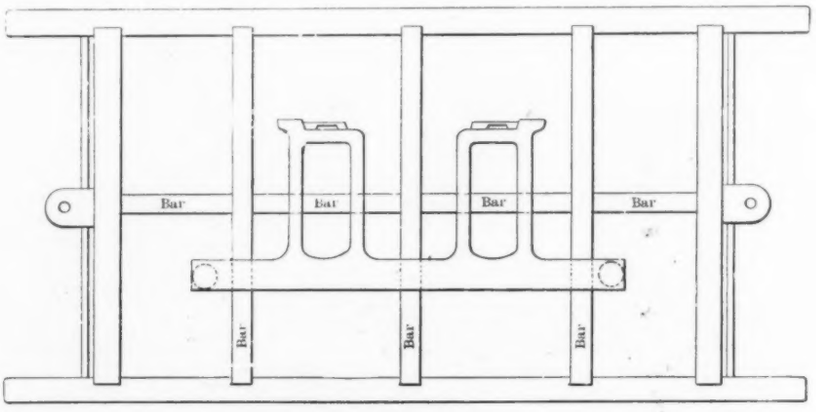

FIG. 3. Plan of Cheek.

THE TWO-PART JOB.

The pattern for the three-part job was made in a jobbing shop without the boss molder being called in, and although it looked to be a good job, and was, as far as finish was concerned, it was an expensive job for the owner, as he was taxed considerably more for the castings than he was when the pattern was reconstructed and made in a two-part flask, not to speak of the extra cost of reconstructing the job. For the second way the boss molder was consulted, and the construction which he designed is shown in Figs. 4, 5, 6, 7 and 8; though there are some undesirable points in his method, it is nevertheless the cheapest way of turning out a perfect casting to size. The placing of the core is a drawback; however, with the sharp edges of the core scraped off and once entered, it slips easily into place. In this method of construction of the pattern several parts were made loose and were pulled into the central cavity of the mold, and several parts of the pattern proper were made in the core. A core print was made to the size of the interior of the frame, and the sides of the pattern were sawed into several parts designated as *B*, *C* and *D* in Figs. 5, 6 and 7. Section *C* was separated from *B* at point *A*, and in section *C* were placed two dowel pins running down into section *B*, thus securing it in the right location with reference to section *C*. To hold it in the sand two

guide pins (see Fig. 6) were inserted, and on the top of the section *C* in the four corners was placed a loose pad *D* (see Fig. 5); section *C* was then fastened to the sides of the core print and on the top face of the latter a groove was cut, the width of a section *E* in the core-box smaller than the core-print of the pattern, this being a frame equal in depth to that of the core-print and perfectly plane on all four sides; then a bottom board was made for it, and provided with dowels to hold it in place on the frame; across the face of this bottom board on the inside of

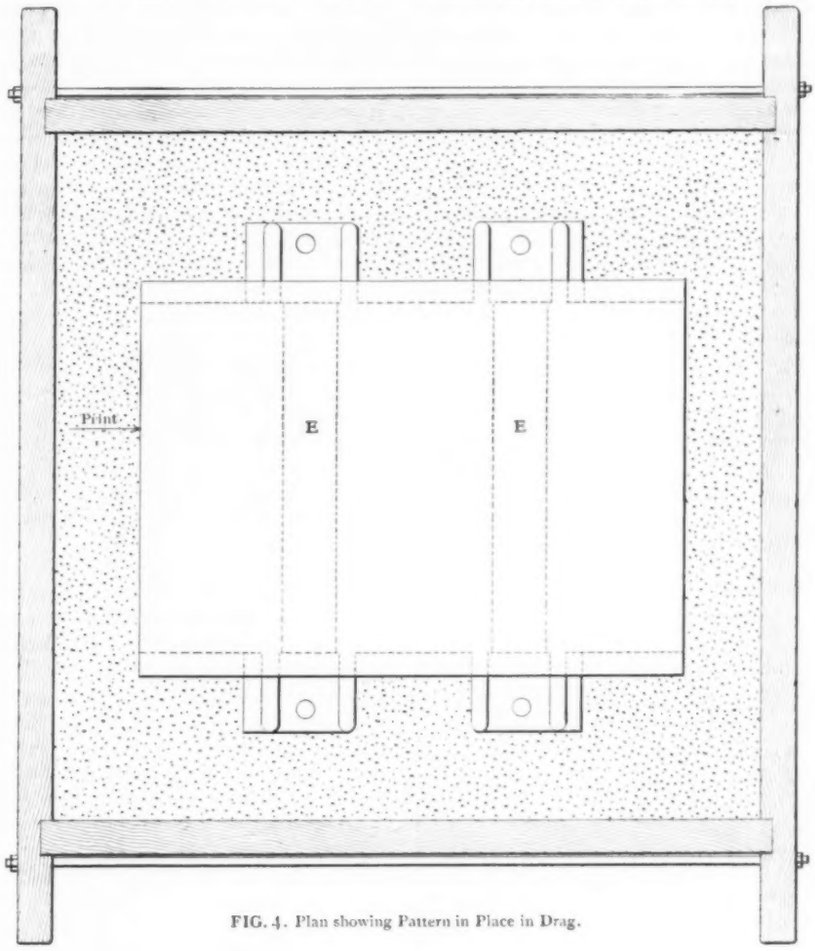

FIG. 4. Plan showing Pattern in Place in Drag.

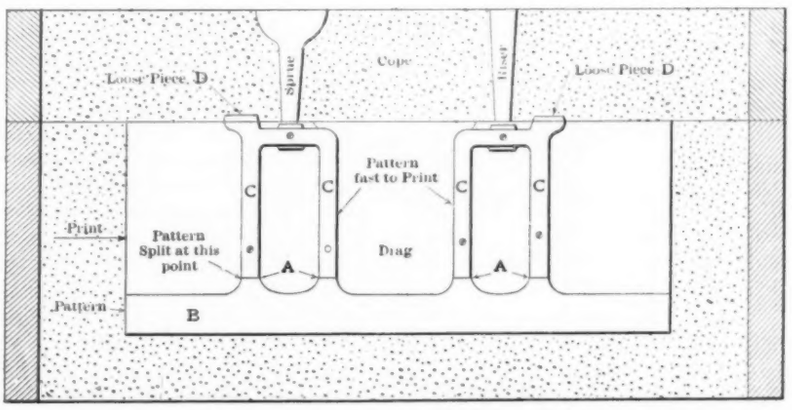

FIG. 5. Vertical Section of Mold with Pattern in Place.

(Fig. 8). This section *E* is partly made in the core and the remainder in green sand. In the groove made in the top of the core print are made the holes for locating the sprue and the riser (see Fig. 7).

A core-box was then made a trifle the box were placed strips *E*, which represent part of the pattern, these were fastened tight to the bottom board, running across the inside of the box until they hit the side walls (see Figs. 7 and 8). Then across the top of the core-box were fastened two strips (Figs. 7 and 8). The strips are to form the bar *J* across from one side of the cast-iron frame to the other (Fig. 1). The bars *J* keep the top of the frame from springing out of place; just before the last cut is taken on them in the planing, this bar is cut away; by this means the castings come alike each time.

MOLDING IN A TWO-PART FLASK.

In making a mold from this pattern in a two-part flask, as shown in the drawing, the two loose pieces *D* are removed and the pattern is set on a flat board,* the loose piece *B* being in place; then with the drag section of the flask resting around the pattern the heap sand is shoveled in, rammed up and tucked in around the frame *C* as it should be; then a bottom board is placed across the top of the drag and the whole affair rolled over; the top board is then removed and the top of the drag slicked off to the desired parting line; then the cope is set in place, and the loose pieces *D* are set in place along with the riser and the sprue. The cope is then filled up and rammed, vented and removed. The two lift hooks are inserted into the top of the core-print, and, the pattern being rapped, it is withdrawn from the sand, leaving the two loose strips *B* down at the bottom of the mold; these sections *B* are then drawn into the cavity made by the removal of the main part of the pattern, which is all plainly shown in Fig. 6. The loose pieces *B* are then removed from the cavity and the core is set in place; in setting of this core the edges of it are scraped so as to let it enter without tearing up the green-sand edges of the mold. Once entered it can be easily shoved into place. The cope is then closed on the drag and the mold is ready for pouring. In Fig. 8 will be seen a view of the core-box; in making this core the core-sand is packed around the walls of the box several inches thick and in the center is placed a lot of cinders for venting the core.

We have previously referred to the objections upon the part of New Zealand and Australian manufacturers of harvesting machinery to their market being used as a dumping ground for what they consider the products of the "pauper labor" of America. It seems that by a vote of their Federal House of Representatives at Melbourne the duty on harvesting machinery imported into Australia has been raised from 12½ to 25 per cent. We believe that the duty on such machinery imported into America is about 45 per cent.

A project is under discussion in Germany for the holding of a world's fair in Berlin in 1912. It is said that there is a fair prospect that provision will be made for such an exposition.

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*Being, of course, upside down, as compared with the position shown in the cuts.—Ed.

Experimental Technology of Deformation of Materials, and Its Application to Metal-Working Processes—IV.

BY H. I. HANNOVER.

SECTION III—EXPERIMENTS ON SHEARING AND THEIR PRACTICAL APPLICATION.

A. EXPERIMENTS AND APPLICATION TO SHEARING.

Consider two plates A and B, Fig. 24, touching each other, and on the surfaces in contact, provided with grooves facing each other and filled with a material G of less hardness than the plates; this material will be divided when A is moved along B in the direction of the arrow, because there will arise a relative displacement of the upper and lower halves of G; but moreover there will arise a small compression of the material in the upper half of G at a, and in the lower half of G at b. If the material which is to be divided is not surrounded on all sides, as in the case now before us, and it therefore is able in part to escape when the plates are moved relatively to each other, the case will be more complicated, i. e., the displacement is accompanied by more intricate secondary actions.

Practically divisions of this kind are executed by means of shears, which are provided with two blades A and B, Fig. 25, between which the material lies, and which move toward each other in such a way that after having divided the material they graze each other closely in passing; and it will now easily be seen that such a division, which is called *shearing*, is not produced simply by a displacement, even if we set aside the small compression referred to. For suppose that B is immovable and that A is moved vertically downward, then the material G, if it is not by special means, such as a vertical screw, kept in a horizontal position, will be subjected to increasing forces P, which produce a moment that makes it turn over and compels it to take an oblique position, the jaws forcing themselves into it like wedges. Under the moving down of A, the plate G will constantly be forced into a more oblique position, until the pressures Q, which arise (see Fig. 26), are large enough to produce a moment equal to that formed by the forces P.

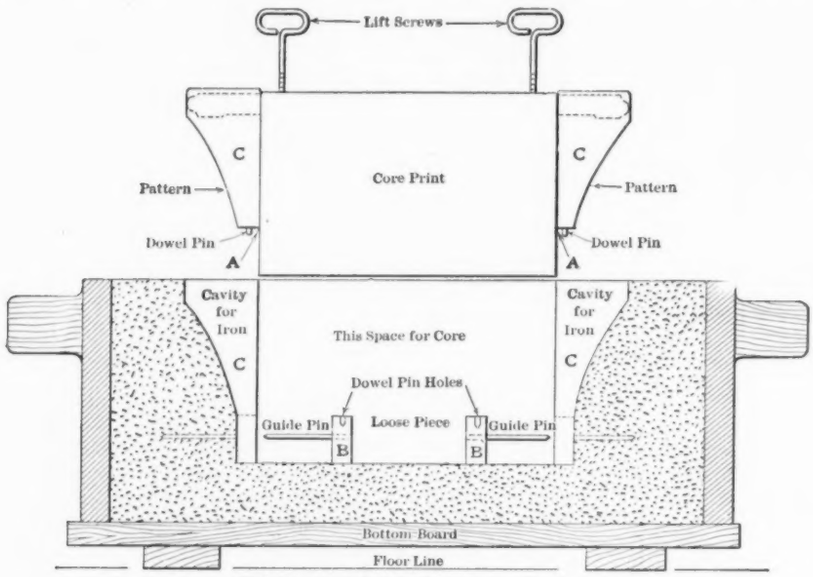


FIG. 6. Removing the Pieces from the Drag.

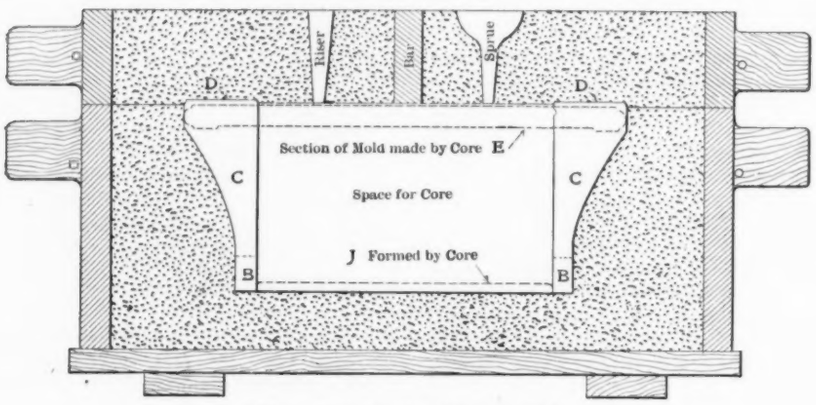


FIG. 7. Vertical Section of Two-part Mold

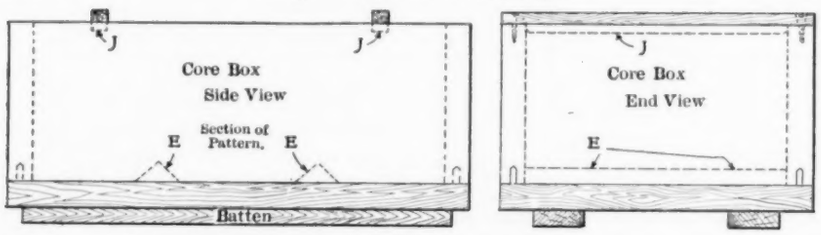


FIG. 8. Side and End Elevations of Core-box.

Under the moving down of A the forces Q will attempt to force A and B each to its side. This is inconvenient, even if A is guided in such a way that it cannot be forced perceptibly sideways, because it will entail the necessity to employ a larger force for shearing than would otherwise be necessary, owing to the rather great friction fQ on the side faces of the blades. If A can be forced sideways, we have besides the shearing a *flaying* of the material, since the blades in that case cannot pass each other closely, whereby the surface of the cut becomes rougher than otherwise. With thin sheets, pasteboard and the like, we even run the risk that the sheet or the pasteboard bends to the blade A, so that it is not cut at all, but places itself along the left face of B. We term it the shears *drivel*.*

Of course we may diminish the great friction fQ on the right-hand side face of the blade A by taking care, that the part of the material from which the other part is to be cut (in the figure the right-hand part) is compelled to keep horizontal during the shearing. This means is very often made use of, and when it is an easy shearing it is done by means of the hand, while in the case of more difficult shearings it is most simply effected by a vertical screw, screwed down on the surface.

But apart from this we have different means for making the blades pass each other closely. The easiest and consequently most employed way is to make the angle of the edges less than 90 degrees, for instance 80 degrees in shears for metals. Hereby two oblique reactions P arise, and a component of each of these forces the blades to pass each other closely, whether the relative movement of the blades is straight, or is an arc movement.

When the angle of the edges for shearing of metals is not made less than about 80 degrees, the reason herefor is partly that in that case the rather sharp blades would tend to be forced so far sideways that they cut each other and injure each other, which, however, may be

*Probably *spring* is better English.—Ed.

prevented in different ways, partly by making the edges sufficiently strong, so that they do not break.

But besides this mentioned sharpening of the edges we may also in other ways force the blades to pass each other closely. In large shears, whose one blade *B* is fixed, while the other *A* is moved straight, *A* is provided with a sufficient guide; while in tailors' scissors and sewing scissors, where one or both of the blades are moved in an arc, there is taken care that the bolt around which the movement takes place is screwed on sufficiently tight. In the common hand shears for cutting metals and in sheep shears (see Fig. 28) the blades are by means of the hand, when closing the shears, forced to pass each other closely, and in paper shears (see Fig. 29) which are also used for shearing thin metal sheets, as for instance tin-foil, leaf-gold, etc., the blades are curved (see the edgewise view of Fig. 29) and elastic, so that the springiness hereby attained, even if the bolt is a little slack during the shearing, keeps the blades close to each other at the point of intersection of the edges.

BENDING AND CRACKING OF THE MATERIAL DURING SHEARING.

We have, however, not yet got very far into the problem, how the division of the material is done when the shearing, shown at the beginning in Fig. 27, goes on further. In Fig. 30 it is shown, according to experiments by Mr. Codron* how the layers in a piece of wrought iron are curved during the continual movement of *A*, and how in front of the edges there arise cracks *u* and *v*, owing to a considerable stretching of the fibers at these points.

The fracture which finally occurs, mainly owing to a displacement, ought of course to pass through the point *o*, which is the middle point of a line between the edges; but practically the two cracks *u* and *v*, owing to a lack of homogeneity in the material and the condition of the edges, will generally not meet, but there will arise a step of varying size on the surfaces of fracture.

Howsoever the facts are, it will be seen that the material near the cut is subjected to a very considerable cold treatment, up to the breaking point, and as cold treatment increases the brittleness (see Section II B) the explanation of the well known brittleness arising by shearing may be sought herein, which brittleness makes it necessary after shearing of structural steel, for instance, to plane the cut edges.

In Fig. 56 will be shown a great deal of lines, detected under the microscope, which have arisen by shearing from slidings in the gliding planes of the crystals near the cut of a pair of scissors.

B. EXPERIMENTS AND APPLICATION TO PUNCHING.

We will now, chiefly referring to Codron, examine the process of punching and, as an example, consider the case where a punch *A*, Fig. 31, punches a bur out of a piece of material *G*, supported on a die *B*. If we regard the punching as a shearing, whereby the bur is cut loose from the other part of the material, it might, by comparing with Fig. 30, be expected that cracks *u* and *v* would arise, as shown in Fig. 32; but by comparing with Fig. 27, it will be understood that the material *G* will bend down in the middle as shown in Fig. 32, and this will produce horizontal stresses of compression in the upper surface of *G*, just as in the top surface of a beam subjected to bending, and stresses of tension in the bottom surface. Therefore the cracks *v* will arise first, while the cracks *u* arise later and have a somewhat accidental direction, because they for a reason not yet mentioned tend to form in an oblique direction inward instead of outward.

This tendency may be understood when we learn that the bur or punching, which falls out by punching of an india-rubber plate *G*, has a shape like a sand glass, as indicated in Fig. 33. This shape is due to the great elasticity of india rubber, which causes that the punch almost reaches the die before the rupture takes place. For suppose that the india-rubber plate consists of layers; then that part of these which is situated beneath the punch will, as already may be seen at the position of the punch shown in Fig. 34, extend sideways, when the punch is going down, so that the part *a b* of the middle layer, Fig. 33, has extended to the size $a_1 b_1$, Fig. 34. When at last the bur is on the point of being cut out, that is when, as mentioned, the punch has almost reached the die, then that portion of the middle layer which will be a part of the bur, will be narrower than $a_1 b_1$, and will, after being cut loose from the plate, contract to a smaller breadth than *a b*, owing to its elasticity.

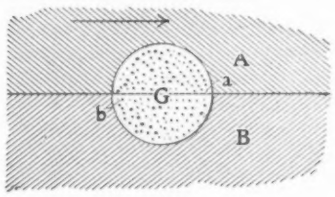


FIG. 24.
Shearing of a Confined Material.

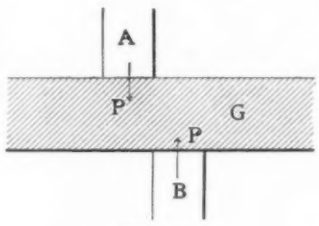


FIG. 25.
Shearing between Blades.

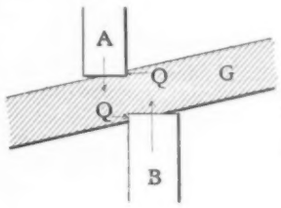


FIG. 26.
Side Thrust on the Blades.

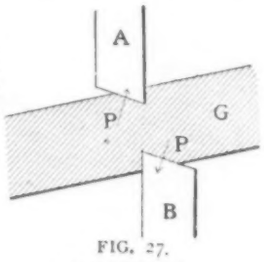


FIG. 27.
Sharpened Blades.

FIG. 28.
Sheep Shears.

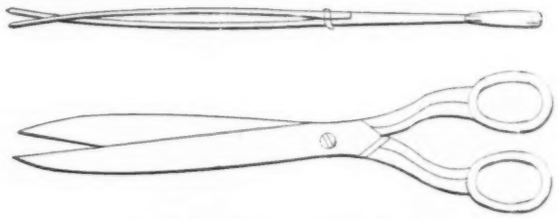


FIG. 29. Shears for Cutting Paper, etc.

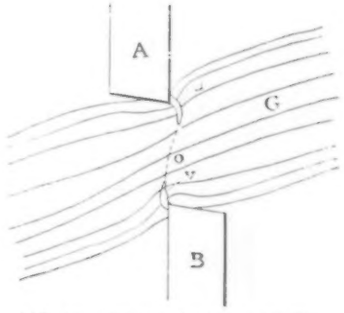


FIG. 30. Effect of Shearing on the Fibers.

*"Expériences sur le travail des machines-outils," Paris, 1902, p. 87, justly very highly praised in the review in AMERICAN MACHINIST, Vol. 26 (1903), p. 422.

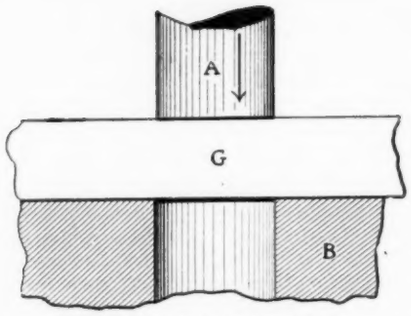


FIG. 31. Simple Punch and Die.

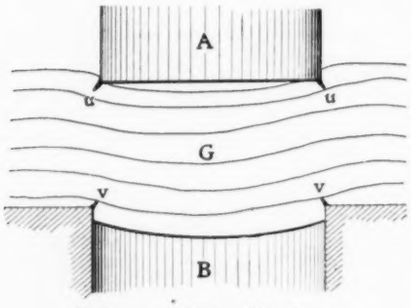


FIG. 32. Bending and Cracking.

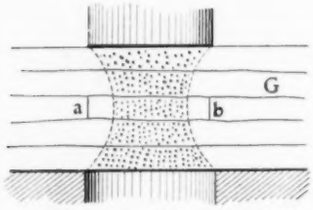


FIG. 33. Punching Rubber.

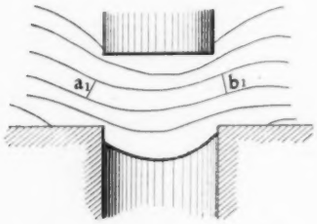


FIG. 34. Commencement of Rupture.

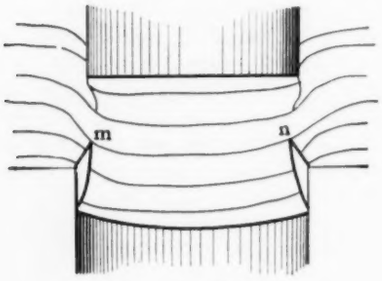


FIG. 35. Punching Iron.

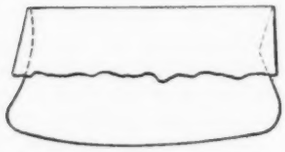


FIG. 36 A Punching Wearing a Collar.

far from being as elastic as india rubber, but nevertheless the bur will have a slight tendency to take the form of a sand glass, and therefore the direction of the cracks above will, at times, be at the beginning oblique inward instead of outward, as shown in Fig. 32. In Fig. 35 such a punching is shown at a somewhat later stage.

Still it will be seen from this figure that when the cracks above and below meet, the bur will, however, not always be able to fall out of the hole; this will be the case if the smallest diameter of the hole *m n* is smaller than the diameter of the punch. In that case it will be necessary that the punch tear some more off the material at the sides of the hole, and this will then, as shown in Fig. 36, fix itself round the bur like a collar. Such a collar is therefore very commonly seen at the outside of the bur from a punching; at times even two may be seen, the one above the other; this will be the case when fresh cracks begin to form during the punching, starting from the edge of the die obliquely inward into the bur. Sometimes the cracks above and below have not yet met when the collar is formed, and the bur falls out.

It is possible to obtain still more variations in the form of a bur, namely, by punching other materials than wrought iron and mild steel, by varying the diameter of the punch in proportion to that of the hole in the die, by varying the angle of the edges, and by using a center punch or punches, whose edges are not lying in the same plane, and so on. It may, for instance, happen that the bur, in order to get loose, leaves a collar below inside the punched hole, instead of bringing it along with itself.

Upon the whole, it will herefrom be seen that the processes of punching are most complex. While the angle of the edges for shearing was made somewhat less than 90 degrees in order to compel them to pass each other closely, there is in punching no cause to make the angle of the edge less than 90 degrees on this account. There can, however, be other reasons, but it is to be supposed that these will be well known to the readers of the AMERICAN MACHINIST, as well as the fact that by punching there arises brittleness just as by shearing.

It would also lead us too far here to discuss the experiments on deformations by bending and torsion. In Section VI deformation by bending will be mentioned briefly.

(To be continued.)

The pressure marked on valves, says the *Valve World*, indicates the pressure to which the valve has been tested by the manufacturer, not the breaking strength nor the safe working strength. Naturally they are not tested up to their breaking strength, and on the other hand they are tested considerably beyond the advisable steady working load.

Milan International Exhibition—II.

BY I. WILLIAM CHUBB.

The exhibition is held just outside the city on two sites, one the Park and the other the Piazza d'Armi. Each is easily reached by a full service of municipal cars from the Piazza del Duomo, the center of the city. The two sites are quite distinct, and as regards the exhibition are connected only by an electric railway on the Gadda system, monophase, 2300 volts, transformed to 360 volts at the motor. The area covered is variously estimated at from 840,000 to 990,000 square meters, of which from 201,000 to 250,000 square meters are covered by buildings. The higher figures are official. Thus there need be no notion of "doing" the exhibition in one day. The exhibits are divided into 10 classes, all international except the Fine Arts. Of the classes the most interesting to readers of this journal are the Transportation by Land, Sea and River Transportation, Decorative Arts, and the miscellaneous industries which include machinery in motion. The nine international classes are further divided into 267 groups, which are again divided into 1186 sections. The Working Hall covers some 130,000 square meters, the Land Transportation Building 25,000 square meters, the Decorative Arts 22,000 square meters, Agriculture 21,000 square meters, Navy and Mercantile Marine 12,500 square meters and Fine Arts section 12,000 square meters; these figures being obviously approximate.

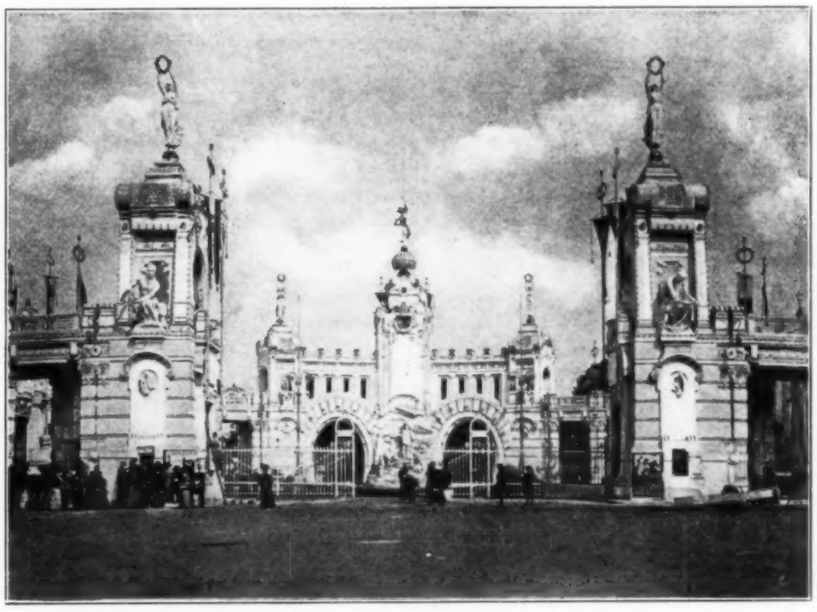
NATIONS EXHIBITING.

Excepting two or three instances, the grouping is international, all articles of a similar character being placed in the same building but classified according to the country. Thus small national courts are formed in each main pavilion. The countries exhibiting officially include France, Germany, Switzerland, Belgium and Austria-Hungary, while most of the European countries, Japan, China, Argentine and Brazil are represented in some way or another. Canada is the only British Colony making a separate effort. Besides the permanent exhibition a number of short-period shows are being held in a hall specially arranged for the purpose. These, however, do not greatly concern themselves with engineering affairs.

One consideration which prevented at any rate many British firms from exhibiting, was the provision that as far as possible machinery in motion was to illustrate a complete series of operations toward a given product. Thus it is claimed the raw material, the processes and the finished result are shown in natural sequence. This condition, though effective in holding back British concerns, has not been rigorously upheld. Then, basing their views on the experience—real or imaginary—of other exhibitions, many

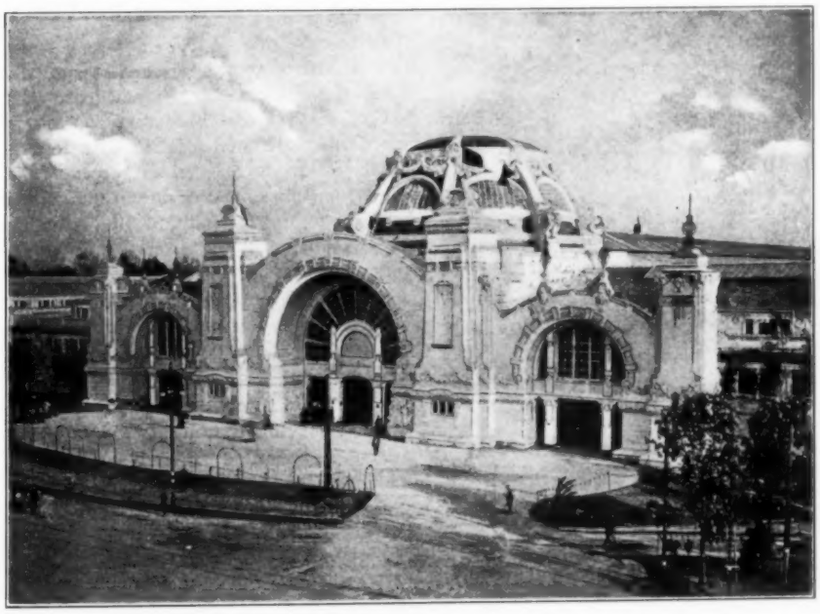
Now wrought iron or steel is certainly

firms have feared that by showing their products thus publicly they are giving away valuable secrets. This again has operated to the detriment of the British section. Little result appears to have come from the Royal decree by which inven-



MAIN ENTRANCE MILAN EXHIBITION.

tions relating to exhibits for which an Italian patent has been granted or applied for are considered as having been worked throughout the duration of the exhibition. One peculiarity is that practically the whole of the exhibits are driven by



WORKING HALL CONTAINING MACHINERY IN MOTION.

electricity from the supply mains. Thus the steam engineering section which usually forms such an attractive feature for the general sightseer, has been eliminated, current being transformed according to the requirements of the exhibitor.

CHARACTER OF THE BUILDINGS.

In all some 80 buildings or more have been put up, with steel skeletons. To the uninstructed person most of them seem, if florid, to be of great beauty, the Belgian Hall—Flemish in character—being specially noteworthy. The Maritime Pavilion is surmounted by a lighthouse with searchlight and one or two private concerns, such as Cook, Ansaldo-Armstrong, of Genoa, and the Thomson-Houston Company, have their own separate halls or kiosks. The buildings have timber frame fronts, the plaster work being held on cane matting. This is the general, though not the only method of finish.

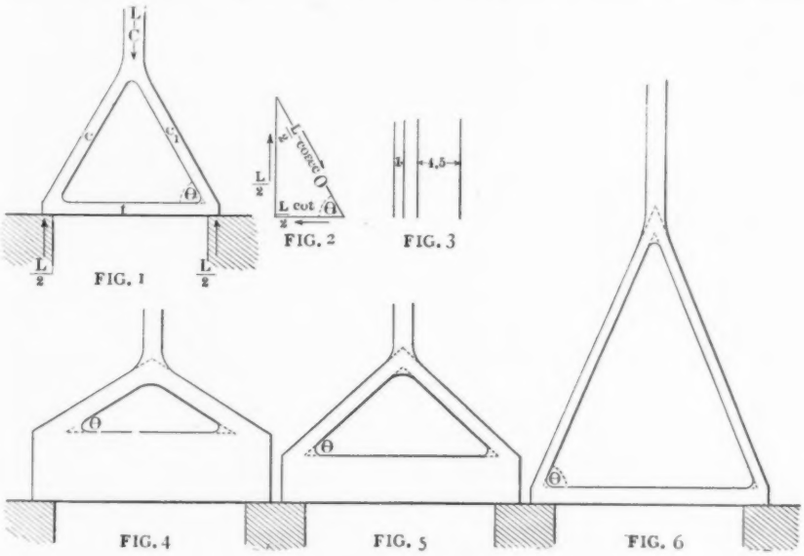
The Park section offers mainly recreation and amusement. A model of the Simplon tunnel is immediately opposite the main entrance, and the buildings include a large concert-room, fisheries exhibit, halls for decorative arts, fine arts, architecture, etc. In the evening, both here and on the other side, the galleries and halls are closed and the space is given up to open air concerts and the ordinary exhibition amusements, including our old friend, the switchback railway, here transformed into Russian mountains, and the glorified roundabout known as Maxim's flying machine. On this side there is little of engineering interest. The Simplon model shows not only the masonry-lined tunnel but the heading held up by timbering of exactly the same character as that used during the progress of the work. A face is shown with rock drills in place and running. Near by is a realistic reproduction of the troublesome inrush of water into the workings. A number of scale models or maps in relief of parts of the Alps tunneled and also drills and other machinery used in piercing the mountains will be found in a hall close to the Simplon model. The latter, by the way, has in front a reproduction in cast of the Iselle entrance, while between the two model tunnels is a piece of statuary illustrated in one of the photographs here reproduced.

HISTORIC RAILS AND OTHER EXHIBITS.

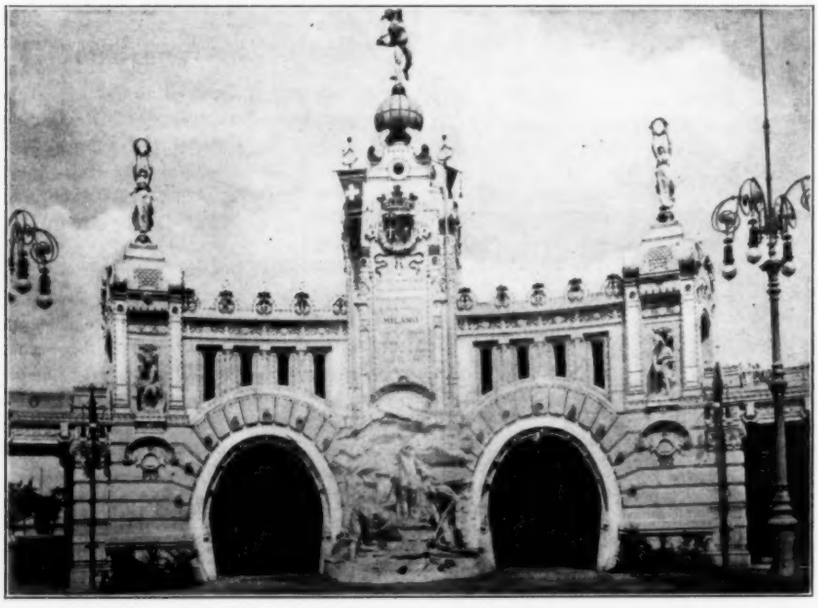
In the section devoted to retrospective transportation America makes no show. The English Institutions of Civil and Mechanical Engineers and the Iron and Steel Institute are represented, but the Institution of Electrical Engineers is out of evidence in the country of Volta and Ferraris. The Institution of Civil Engineers sends a commemorative panel—the oak framing coming asunder at the joints owing to the heat—with portraits of past presidents and a tablet inscribed: "Dedicated by the Institution of Civil Engineers to the Engineers of Italy. To the worthy sons of the great constructors of the Roman Era. Through the uninterrupted revolutions of the centuries The Vigilant Custodians of ancestral traditions. As a token of the great esteem in which they are held by their Colleagues of Great Britain." The Iron and Steel Institute shows a number of more or less historic rails such for instance as a section of the first bessemer-steel rail ever rolled. It was made from an ingot cast at Baxted House, St. Pancras, London, from best Blaenavon pig iron and rolled at Dowlais in the autumn of 1856. Another exhibit is a piece of bessemer-steel rail laid at Crewe station in 1863, turned in 1866 and removed in 1875. It is estimated that the tonnage over it was 72,000,000, with a loss to the rail in weight of 20 pounds a yard. By the way, according to the Bessemer autobiography published last year, the first steel rail was laid at the Camden Town Goods Station, London, N. W., of

the London and North Western Railway, in May, 1862. The Mechanical Engineers send further historic rails dating from 1788 and the British Board of Education contributes a number of drawings of old locomotives of the type which will be familiar to visitors to South Kensington. In this division the German postal system well illustrates its historical development with lay figures, etc.

Other divisions of more or less interest are the social economy section, where America is represented by the American Institute of Social Service, the exhibit consisting apparently of a number of reports, on stands and freely bedecked with the Stars and Stripes. The International Peace Society has a pavilion placed next to the Russian hall, the latter not open. The Peace Pavilion is chiefly remarkable for a number of symbolic and realistic pictures and for the scanty recognition of American and British efforts. In the decorative arts section the Italians show some really excellent examples of hammered iron work, especially in the way of gates. In Great Britain, at any rate, this art seems to be dying out in favor of more mechanical production, but both in the way of grotesques and of natural figures conventionalized according to the material, are to be found scattered in the various courts, and, in particular, Italian agencies have made good use of machine tools. But officially the States are quite unrepresented and indeed make the poorest show of any of the countries in the front rank. On the other hand, Canada has a



THE MOST ECONOMICAL ANGLE.



ENTRANCE TO SIMPLON TUNNEL MODEL.

the Italian court has something to show. The French too make good exhibits here.

COMPARATIVELY FEW EXHIBITS FROM AMERICA.

Looking at the exhibition generally, Italy occupies rather more than half the space, while the whole of the European countries are in evidence. Of foreign sightseers, Americans at the beginning of July seemed to take command. Yet in inorganic material America is almost unrepresented. Doubtless here distance has been the operating factor. It is true that some engineering products of the States pavilion to itself in the Park and is evidently bidding courageously for Italian trade. Properly qualified observers have suggested that Canadian furs and fruits are likely to prove successful in northern Italy. In the exhibit much is shown in the way of Canadian products, natural and artificial, but nothing of an engineering nature excepting one or two grindstones. Above all there is a very general and obvious endeavor in this pavilion to supply just enough information to awaken further interest. Most of the engineering exhibits are on the other side, on the parade ground.

Economy of Material in Framed Structures.

In making a design of a framed structure which is required to sustain a given load, the material should be distributed uniformly. By uniformity we mean that all the elements composing the structure should be equally capable of resisting the stresses to which they are subjected. Remembering that the strength of a structure is that of its weakest part, if one element is stronger than is necessary the additional material is wasted, unless it is introduced for some purpose other than that which we are now considering.

In the use of cast iron there is a great opportunity to waste material, especially when the structure is designed to support a very heavy load. The practical man, in his desire to secure a factor of safety, is liable to introduce a certain percentage in the wrong place, at the same time adding nothing to the strength of the structure as a whole. In cast iron this is sometimes done intentionally, in order to avoid stresses due to unequal cooling of the casting, when one part is thicker than those adjacent to it. For this and other reasons, the subject is a complex one. After careful attention has been given to the design, the casting itself may bear not more than a resemblance to its original which was based solely upon theory.

The illustrations here given exhibit graphically the amount of material which theory calls for, in order that the elements of a framed structure may be correctly proportioned to resist the compression and tensile stresses. A discussion of other stresses is purposely omitted in order that attention may not be diverted from those which form the subject of this article.

The metal selected is cast iron, on account of the great difference between its

ability to resist tensile and compression stresses. The illustrations are consequently more pronounced than they would be if steel were introduced. The formula given below is, however, applicable to any material in use.

Fig. 1 is a triangular frame supported at the extremities of its base, and sustaining at its apex a load L, which acts in the direction of the arrow. In Figs. 1, 4, 5 and 6, it should be understood that the thickness of the metal at right angles to that which is shown in the drawing is supposed to be uniform; and that the dimensions of the element c are correctly proportioned to resist the compression due to the load L. Instead of distributing the material in the form of a T, the cross section is supposed to be rectangular, which will simplify the illustrations which follow.

In Fig. 1 the elements c and c_1 are in compression, while the element t is in tension. One-half of the load L is supported at each extremity of the base; i.e. the reaction of each support $= \frac{L}{2}$ represented by the perpendicular of the right triangle, Fig. 2. The hypotenuse drawn parallel to the element c_1 is equal to $\frac{L}{1} \times$ cosec. θ; and the base $= \frac{L}{2}$ cot. θ. These represent respectively the compression stresses in c and c_1 and the tensile stress in t. The material contained in the elements c, c_1 and t, is equal to the sum of the lengths of the elements c and c_1 is equal to the section area of these elements increased by the length of the element t, multiplied by its section area. The length of each of the elements c and c_1, is equal to the length of one-half of the element t multiplied by sec. θ; or the sum of the lengths of the elements c, c_1 and $t = t$ sec. $\theta + t$.

The compression in each of the elements c and $c_1 = \frac{L}{2} \times$ cosec. θ. $\frac{\frac{L}{2} \text{ cosec. } \theta}{C}$ = section area of each of the elements c and c_1, in which C represents the number of pounds per square inch the material is calculated to resist in compression..

$\frac{\frac{L}{2} \text{ cot. } \theta}{T}$ = section area of element t, in which T represents the number of pounds per square inch the material is calculated to resist in tension. Therefore t sec. $\theta \times \frac{\frac{L}{2} \text{ cosec. } \theta}{C}$ is the volume of the elements c and c_1 and $t \times \frac{\frac{L}{2} \text{ cot. } \theta}{T}$ is the volume of the element t. The sum of the volumes of these elements is therefore equal to

$$t \times \frac{L}{2} \left(\frac{\text{sec. } \theta \text{ cosec. } \theta}{C} + \frac{\text{cot. } \theta}{T} \right).$$

In order to simplify the contents of the parenthesis, the constant factor outside may be increased as follows: Let $C =$ 4.5 T, which is an average proportion between the compression and tensile strength of cast iron (i.e. 90,000 : 20,000) exhibited in Fig. 3. The expression may therefore be written in the form

$$t \times \frac{L}{2} \times \frac{1}{T} \left(\frac{\text{sec. } \theta \text{ cosec. } \theta}{4.5} + \text{cot. } \theta \right).$$

That we may determine the value of the angle θ between the elements c and c_1 and the element t, it is only necessary to compute the value of the contents of the parenthesis, which evidently changes with θ. If this angle be selected at random, we may have such exaggerated results as are represented in Figs. 4 and 5. For $\theta = 32$ degrees, Fig. 4, about double the material is introduced that would be needed for the angle which would be best adapted to the above proportion between C and T. For $\theta = 42$ degrees, Fig. 5, the material is reduced to about one and a half times its minimum value. As the angle increases, while the lengths of the elements c and c_1 increase in length, the section area of each of the elements c,c_1 and t diminishes, thus reducing the total volume until the minimum is reached at about 67 degrees, Fig. 6.

When this angle is exceeded, while the section area of all the elements continues to diminish, the total volume increases. This is due to the rapid increase of the length of the elements c and c_1. The formula which is applicable to any material is tan. $\theta = \sqrt{\frac{C+T}{T}}$, in which C and T represent respectively the safe working compression and tensile stresses.

The following table gives the percentage of material which is wasted for values of θ which are greater, and for those which are less than 67 degrees.

Angle.	Per cent.		Angle.	Per cent.
68°	$\frac{1}{2}$	. .....	66°	$\frac{1}{10}$
69°	$\frac{3}{4}$	. ....	65°	$\frac{2}{3}$
70°	$1\frac{1}{4}$	.....	64°	1.
71°	$2\frac{1}{4}$	.....	63°	$1\frac{1}{2}$
72°	$3\frac{1}{2}$	.....	62°	$2\frac{1}{2}$
77°	20.	..... .	57°	9.

A similar table may be readily computed for any other proportion between the compression and tensile stresses.

Intercoolers for Air Compressors.

BY H. V. HAIGHT.

A few years ago, in 1899, I undertook the design of two air compressors, each having a capacity of 4000 cubic feet of free air per minute. There were a number of features in the specifications which were at that time unusual, and one of them was a guarantee of the efficiency of the intercoolers. These were guaranteed to reduce the temperature of the air passing through them to within 15 degrees F. of the temperature of the cooling water supplied. In each case there was a penalty of $150 per degree for every degree more than 15, and in the case of one of the machines there was a bonus of $150 for every degree less than fifteen.

Very little information was available from which to determine how large to make the intercoolers to meet the guarantee. An article in the AMERICAN MACHINIST of 1896 gave the results of a test made by F. C. Weber on a Norwalk compressor, but this was tested at only one speed, and the difference in temperature

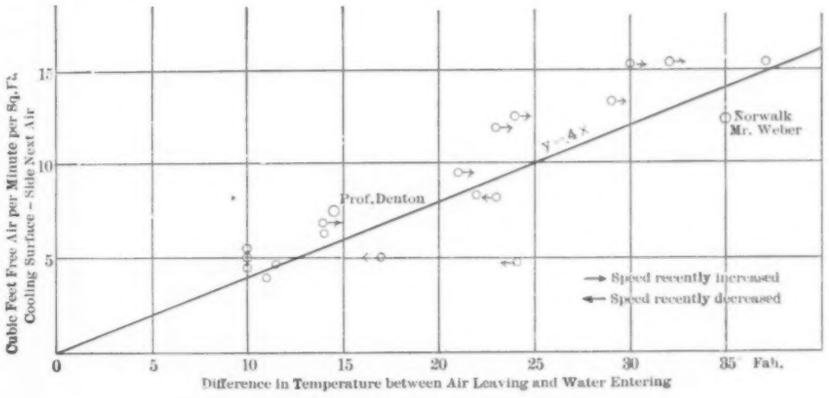


FIG. 1. PLOTTED RESULTS OF THE TESTS.

was 35 degrees, so that it did not furnish sufficient data for guidance. Professor Denton's students had recently made a test of a Rand compressor, but it also was tested at only one speed and the difference in temperature was 15 degrees. This compressor was, however, still available for tests, and Mr. Rand kindly sent Mr. Weber to make further tests on it at several different speeds. The results of these tests are shown in the accompanying table. Two points should be noted here: (1) that the compressor was run but a short time at each speed, not long enough (as will appear later) for the temperatures to come to their final values, and (2) that two sets of readings were taken, one as the speed was being increased step by step, and one as it was being decreased step by step. There were also two sets of experiments made, with different methods of water circulation, as noted in Fig. 1.

The results of these tests were plotted as shown in Fig. 1. The results of the

tests of the Norwalk compressor and of the test by Professor Denton's students are shown on the same diagram. The circles with arrows pointing to the right show that when the temperature reading was taken, the speed of the compressor had recently been increased, while the circles with arrows pointing to the left show readings at which the speed had recently been decreased. It appeared reasonable to suppose that if the machine had been run a longer time at each speed the points plotted would have been moved in the direction shown by the arrows, that is, they would lie more nearly on the straight line drawn through the origin. The straight line was taken as the basis for designing the required intercoolers.

In designing the intercoolers the extra cost of making them larger than necessary was compared with the bonus which might be obtained on one of them, and it was decided that it would pay to reduce the temperature to within 5 degrees and thus earn $1500 bonus. They were built

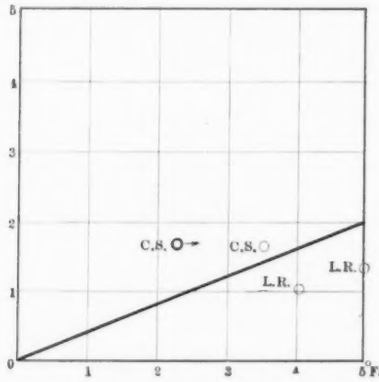
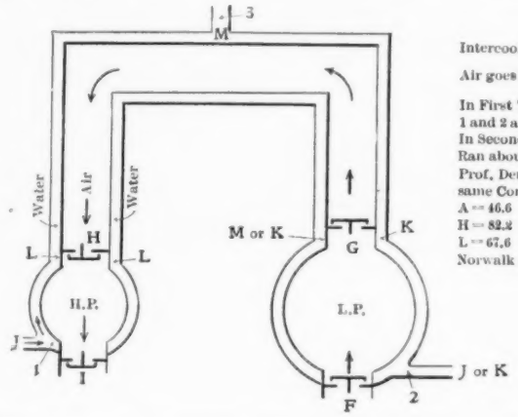


FIG. 2. TEST OF A LARGE COMPRESSOR WITH LARGE INTERCOOLER.

accordingly and earned the bonus. Fig. 2 shows the corner square of Fig. 1 drawn to a larger scale, with the results of the tests on the two large intercoolers plotted. While the points do not lie on the line, they do lie on opposite sides and within about one degree F. of it, which is as close as could be expected when it is considered that the tests were made by ordinary mechanics, that the runs were of short duration, and that the thermometers were common chemical thermometers costing less than a dollar each.

A number of interesting conclusions may be drawn from a study of the diagram in Fig. 2. It will be evident that to reduce the temperature of the air to 10 degrees above the temperature of the water requires an intercooler twice as large as one to reduce the temperature to 20 degrees above the temperature of the water, while an intercooler to reduce the temperature to 1 degree above the temperature of the water would require to be ten times as large as one to reduce the temperature of the air to 10 degrees above that of the cooling water. At a time when the calculus was fresher in my mind than at present I deduced from the above diagram the rule that the quantity of heat transmitted through a given area of the tube surface varies as square of the difference in temperature.

The intercooler, of the Norwalk compressor was of the water-tube type, that is, the water flowed through the tubes and the air flowed around them. The Rand intercooler of the table and Fig. 1 was of the air-tube type, while the two large intercoolers referred to in Fig. 2 are of the water-tube type. In each case, however, the area of cooling surface was measured on the side exposed to the air. The tests show little, if any, difference in



Intercooler { 75.4 Sq. Ft. of Outside Surface. / 60 " " " Inside "

Air goes through Inside of Pipes.

In First Table Water Enters at 1 and 2 and Leaves at 3.
In Second Table Water Enters at 1 and Leaves at 2.
Ran about 15 Minutes at each Speed.
Prof. Denton's Students Tested the same Compressor — see Fig. 1.
A = 46.6 B = 451 E = 80 F = 80.7 G = 210.75
H = 82.2 I = 208.1 J = 60.4 K = 84.8
L = 67.6 M = 74.2 H–L = 14.6 W = 7.5
Norwalk (Am. Mach. 1896) H–L = 35 W = 10.5

Rev. Per Min.	Air Per Min. Cu. Ft. Free Air.	Air Per Min. Lbs.	Press Lbs. Intere'r.	Press Lbs. Rec'vr.	Temp'r Air Fah'r. Atm.	Temp'r Air Fah'r. Outlet L. P.	Temp'r Air Fah'r. Outlet Intere'r.	Temp'r Air Fah'r. Outlet H.P.	Temp'r Water Fah'r. Supply.	Temp'r Water Fah'r. Outlet L. P.	Temp'r Water Fah'r. Outlet H.P.	Temp'r Water Fah'r. Outlet Intere'r.	Weight of Water Per Min.		Cu. Ft. Per Sq. Ft. Inside Surface.
A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	T.	H.–L.	W.
31	300	23.9	30.5	63	39	160	66	134	45	60	56	63	64.8	10	5
32	310	24.75	30.5	64	39	162	66	134	45	60	56	63	64.8	10	5.2
28	271	21.6	30.5	63	39	161	63	134	45	56	54	57	148	10	4.5
29	280	21.4	30.5	63	39	160	62.5	130	45	54	51	54.5	148	11.5	4.7
25	242	19.3	30.5	62.5	39	160	61	129	44.5	54	50	52	148	11	4
43	416	33.2	30.5	65	38	167	64	136	44.5	54	50	53	148	14	6.9
39	377	30.1	30.5	65	38	169	64	139	44.5	54	50	54	148	14	6.3
59	571	45.6	30.5	65	38	181	72	146	44.5	56	51	57	148	21	9.5
74	716	57.2	30.5	65	38	189	75	150	44.5	57	52	59.5	148	23	11.9
77	745	59.5	30.5	65	38	192	76	153	44.5	58	52	60	148	24	12.4
82	793	63.2	30.5	65	38	203	81	154	44.5	59	52	62	177	29	13.2
94	910	72.6	30.5	65	38	205	82	154	44.5	60	52	62	160	30	15.2
51	493	39.4	30.5	65	38	181	73	136	44.5	58.5	50	58	130	23	8.2
52	503	40.2	30.5	65	38	181	72	137	44.5	59	50	58	130	22	8.4
93	920	73.5	30.5	65	38	197	82	144	44.5	63	50	60	148	32	15.3
93	920	73.5	30.5	65	38	204	88	150	44.5	66	51	62	130	37	15.3
29	280	22.4	30.5	63	38	190	74	149	44.5	60	50	61	148	24	4.7
31	350	24	30.5	64	38	177	66	140	44.5	58.5	49	59	148	17	5

TEST OF INTERCOOLER ON 14x22x22 DOUBLE COMPOUND RAND AIR COMPRESSOR.

efficiency between the two types, but as the outside area of a tube is greater than the inside, it takes less tube for the water-tube type to give the same cooling surface.

It may also be noted that points below the line in Fig. 1 indicate a lower efficiency of transmission of heat than points above the line. The Norwalk compressor noted had copper tubes, while the others had iron tubes, which would indicate that copper tubes are less efficient for the purpose than iron tubes. This is probably due to the fact that copper tubes are very smooth, while iron tubes are somewhat rough, which practically increases the real area of the surface, somewhat on the principle of a pin radiator or an air-cooled automobile-engine cylinder. Of course there are places where the corrosive nature of the water makes it advisable to use copper tubes on account of their greater durability; but the two large intercoolers above mentioned have been in constant use for six years, and the iron tubes are still in good condition, and none of them have been replaced.

The straight-line formula deduced from and noted on Fig. 1 has been used since 1899 for designing large numbers of intercoolers, and such tests as have been made have given results agreeing substantially with the formula.

Sherbrooke, Que.

The latest acquisition of John Penton, of Cleveland, is a publication known as *Boating*, which is devoted to boats of all kinds, ranging from canoes to motor boats and yachts. It is an exceedingly attractive thing, and the August number, which is before us, is well calculated to stimulate interest in boating, even among those who may have thought little or nothing of it previously. We are glad to observe that *Boating* adds another technical journal to the list of those which are standard size—9x12 inches. It is published by the Penton Publishing Company, Cleveland, Ohio.

The Metropolitan Railway Company in London is selling tickets from a slot-machine to relieve the crush at the "booking-window."

Cast-Iron Crushing Loads and Microstructure.*

BY W. J. KEEP.

The Crushing and Tensile Tests were made by H. Diederichs, Assistant Professor of Experimental Engineering, Sibley College, Cornell University. The Report on the Microstructure is by Albert Sauveur, Assistant Professor of Metallurgy, Harvard University, and proprietor of The Boston Testing Laboratories. The photomicrographs accompanyi his report were taken and specimens were polished and etched in the Metallographical Laboratory of Harvard University by H. M. Boylston, S.B. The test specimens for all tests were prepared by the author.

The object of this paper is to make more complete the so-called A. S. M. E. series of tests on cast iron, which are recorded in the *Transactions* of this Society, in vols. xvi., xvii., xix., xxi., xxii. and xxv. (See second foot note.) It was intended at this time to present Impact tests of these series of casts, but the special apparatus required and the peculiar results obtained made it advisable to delay its representation.

This series of tests is valuable on account of its completeness and because a full chemical analysis was made of each size of test-bar of each of the 19 series of casts.

One pair of test-bars of the Riehle shape .692″ diameter, also one pair of the same shape 1.13″ diameter, of each of the 19 series, were tested in tension by Prof. R. C. Carpenter of Sibley College, and recorded in *Transactions* XVII., pp. 726 and 727. A pair of bars, 1.13″ diameter, from each series was ground true and tested in tension on an Emery testing machine by Prof. Ira H. Woolson, at Columbia College (ibid., pp. 728 and 729).

All of the original test-bars are carefully preserved for future tests, consisting of four bars 13″ long of each size from 1″ to 4″ square of each of the 19 series.

Table I. contains crushing tests of bars, .692″ and 1.13″ diameter, to correspond with the tensile tests already referred to of the same sectional area and of the same iron.

The length of all of these test-pieces for crushing was three times the diameter. They were carefully turned to size with end faces parallel and bedded with sheet copper.

From these records the chart (Fig. 1) was prepared, showing the same general variation in crushing strength for variations, in size and in silicon, that was found in transverse and tensile strength. (See vol. xxv., pp. 895 and 898.)

Physical Composition of Castings.

The variation in structure between the edge and the center of a round casting, and the corner, side and center of a rectangular casting, is shown in Tables II., III., and IV. While there does not seem to be any difference in the size of the grain under the microscope, even when magnified 500 diameters, yet there is a very great difference in strength.

All test-pieces in Tables II., III., IV. and VI. were cut from bars of one square inch area, of Series 2, with silicon 1.21 per cent., and all were poured from iron taken from the cupola at the same time.

For another interesting test record, a block of cast iron 9 inches square by 18 inches long was cut longitudinally into 9 pieces, and test-bars, 1.13″ diameter, were turned from each piece. The average tensile strength from the bars from the corners was 25,100 lbs., from the sides 19,913 lbs. and from the center 15,730 lbs (Vol. xxv., p. 914.)

Table V. gives the strength of a test-piece cast and tested 1.13″ diameter, one cast and tested 1″ □, and another cast 1″ □, but which had the corners turned off, and still another with corners and sides removed. The difference in strength between a small and a large cast-ing is shown in Table I. and in Figs. 34 to 43.

The reason for dwelling upon this at such length is that very few realize that a variation in the size of a casting causes a greater variation in strength than a variation in chemical composition; and that whatever size of test-bar is used, the strength of any other size of casting must be approximated by a comparison with a

*Presented at the Scranton meeting of the American Society of Mechanical Engineers.

TABLE I.

CRUSHING TESTS OF SHORT CYLINDERS.

No. of Series.	No. of Test Bar.	Cylinders .692″ Diam. × 2″ Long.† Crushing Load. Maximum Load per sq. in.	Crushing Load. Average.	Length at Max. Load.	Compression per 1,000 lb.	No. of Test Bar.	Cylinders 1.13″ Diam. × 3.4″ Long.§ Crushing Load. Maximum Load per sq. in.	Crushing Load. Average.	Length at Max. Load.	Compression per 1,000 lb.	Average per centage of Silicon.
1	....	.....	.....	.....	.....	22	.....	76,280	*	.....	0.80
2	....	.....	.....	.....	.....	43	76,300	.....	3.18	.....	.....
						44	72,000	74,100	3.20	.002834	1.21
3	11	84,906		1.86	.....	65	76,440	.....	3.20	.....	.....
	12	84,053	84,480	1.87	.004256	66	78,000	77,220	3.24	.002344	1.88
4	....	.....	.....	.....	.....	87	69,440	.....	3.16	.....	.....
	16	.....	80,293	1.90	.003391	88	65,240	67,340	3.20	.003267	2.01
5	19	71,040		1.84	.....	109	62,320	.....	*	.....	.....
	20	65,786	68,413	1 87	.005652	110	58,200	60,260	3.23	.002821	3.19
6	23	79,653	.....	1.87*	.....	131	65,200	.....	3.14	.....	.....
	24	81,648	80,651	1.86	.004463	132	58,360	61,780	3.14	.004208	3.04
7	27	77,760	.....	1.86*	.....	153	73,480	.....	3.19	.....	.....
	28	79,253	78,506	1.85*	.004926	154	67,160	70,320	3.20	.002915	0.93
8	31	76,133	.....	1.88*	.....	.....	.....	.....	.....	.....	.....
	32	75,573	75,853	1.90	.003883	175	.....	66,700	3.21	.002849	1.17
9	....	.....	.....	.....	.....	197	71,300	.....	*	.....	.....
						198	69,640	70,470	3.21	.003606	1 07
10	....	.....	.....	.....	.....	219	59,720	.....	*	.....	.....
						220	69,400	64,560	3.22	.002788	2.24
11	....	.....	.....	.....	.....	241	.....	68,680	3.19	.003575	2.71
12	47	61,680	.....	1.86	.....	263	57,200	.....	3.17	.....	.....
	48	63,733	62,706	1.80	.097229	264	59,000	58,100	3.17	.003959	3.50
14	55	77,253		1.90	.....	295	68,300	.....	3.20	.....	.....
	56	75,786	76,520	1.89	.003639	296	69,780	69,040	3.18	.003541	2.82
13	51	74,183	.....	1.90	.....	275	77,840	.....	*	.....	.....
	52	80,720	77,498	1.89	.003617	276	68,500	73,170	3.22	.002460	3.18
15	59	71,680	.....	1.86	.....	307	76,000	.....	3.10	.....	.....
	60	71,880	71,600	1.85	.006400	308	72,940	74,470	3.15	.003693	3.50
16	63	85,040	.....	1.86	.....	.....	.....	.....	.....	.....	.....
	64	84,880	84,920	1.88	.004082	.....	.....	.....	.....	.....	1.76
18	67	107,413	.....	1.87	.....	65	90,920‡	.....	3.18	.....	.....
	68	105,200	106,306	1.88	.003136	66	80,000	85,460	3.18	.002584	2.06
19	....	.....	.....	.....	.....	73	88,680‡	.....	3.21*	.....	.....
						74	82,800	85,740	3.20*	.002273	0.77

† All cylinders .692″ diameter, were cut from the tensile bars of Table xxvii, p. 726, vol. xvii. *Transactions* A. S. M. E. ‡ Cylinders 65 to 74, 1.13″ diameter, were from tensile bars of Table xxviii, p. 727, *ibid.* For tensile tests of Series 18, see test bars 73 to 83, and for Series 19, see test bars 103 and 104, Table xxxii, p. 729, *ibid.* § All cylinders 1.13″ diameter, except for Series 18 and 19, were cut from transverse test bars cast 1.13″ diameter, Table xxiv, p. 723, *ibid.* * Short column failure, all others long column failure. For a full chemical analysis of all these series, see pp. 1100 to 1107, vol. xiv, *ibid.*

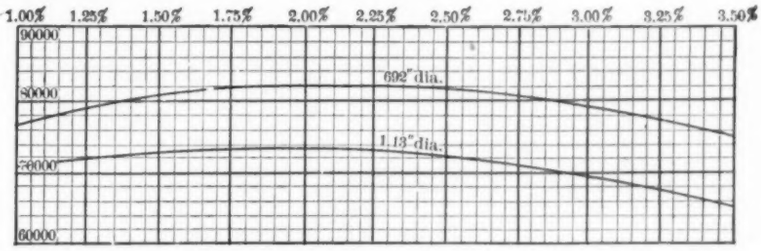


FIG. 1.—CHART OF CRUSHING STRENGTH SHOWING APPROXIMATE RELATION OF STRENGTH TO SIZE OF CASTING AND TO THE PERCENTAGE OF SILICON (Chart gives the strength per square inch).

TABLE II.

Crushing Tests of ½" Cubes.	Maximum Load. Actual.	Lb. per □".	Av. per □".
½" cubes from corner of 1" □ test bar	21,760 21,970	87,040 87,880	87,460
½" cubes from side of 1" □ test bar	18,780 18,990	75,120 75,960	75,540
½" cubes from center of 1" □ test bar	17,120 17,410	68,480 69,640	69,060
½" deep × 1" □			112,700

TABLE III.

Tensile Tests of ½" □* Bars.	Maximum Load. Actual.	Lb. per □".	Av. per □".
½" □ × 6" bars from corner of 2" × 1" bars	3,700 3,280	20,453 18,131	19,192
½" □ × 6" bars from side of 2" × 1" bars	3,520 3,410	19,453 18,297	18,870
½" □ × 6" bars from center of 2" × 1" bars	3,520 3,270	19,453 18,076	18,764

* Three inches at the center was turned down to a diameter of .480". We used 2" x 1" bars because we were short of 1" □ bars of Series 2.

TABLE IV.

Crushing Strength per □" of ½" Cubes cut from each Size of □ Dry Sand Bars of Series C of Tests by the American Foundrymen's Association.

	Distance of Cube from Surface.	½" □	1" □	1½" □	2" □	2½" □	3" □	3½" □	4" □
A. F. A. Series C, Si. 2.01 %.	First ½"	154,000	111,600	88,240	87,000	79,200	72,680	68,400	65,640
	Second "			83,000	77,360	72,200	67,400	66,040	61,000
	Third "					71,330	64,160	64,320	59,520
	Fourth "							63,520	56,800
	Center "	154,000	99,560	83,000	72,040	71,360	63,800	63,520	56,880
	Per □" of bar	154,000	*107,588	86,492	80,152	74,832	67,468	65,864	60,312

* The crushing load per sq. in. is found by taking twice the sum of the loads on cubes outside the center + the load at the center, and recording the average.

TABLE V.

Crushing Tests—Sections of 1" □ Test Bars.	Maximum Load. Actual.	Average per □"	Length at Max. Load.	Compression per 1,000 lb.
Cylinder 1.13" diameter × 3.4" long	76,300 72,000	74,100	3.18 3.20	.002834
1" □ × 3" long	† 76,000	(79,700) 76,000	(2.83) 2.91	(.002133) .001071
Cylinder 1" diameter × 3" long	60,480	77,020	2.80	.003307
Cylinder ½" diameter × 2½" long	30,800	69,710	2.18	.002272

† See note Table VI.

series of tests of such sizes of castings, and cannot be calculated by a mathematical formula. (See charts and tables for approximating transverse and tensile strength, vol. xxv., pp. 895, 898 and 901.)

Best Form of Test-piece for Crushing Tests.

The specimen should be cast and tested of one square inch area and 1.13" diameter. It will not do to cut a test-piece from a larger casting, because wherever cut it will not represent the structure of such casting.

A length proportioned to the diameter should be fixed upon as standard. The conditions in Tables VII. and X. seem best.

Relation of Strength to Length of Test-Piece.

As there were not enough round bars in Series 2 for all crushing tests, 1" □ bars were used for Table VI.

Referring to Table II., we see that the strength of a ½" cube, cut from the center of a test-piece 1" □, is 69,060 lb. per □"; when cut from the corner the strength is 87,460 lb. per square inch, but when a section 1" □ × ½" thick is cut clear across the test-bar and is tested, it gives 112,700 lb. per □". A ½" cube from the side of a test-bar 4" □ gives 56,880, but a section 4" □ × ½" thick would show a greater strength per □" than the section 1" □ × ½" thick from a test-bar 1" □.

The outside metal in a larger section prevents the metal at the center from being crushed.

Table VI. shows that as the length increases the strength decreases. All specimens less than 3 inches long fail as a short column—that is, do not bend but break in pieces. From 2½ to 3 times the diameter has generally been considered best.

The bending that takes place in long test-bars when the crushing force is applied to flat ends may be largely avoided if the test-bar for the crushing test is held in the grips of the machine the same as the tensile bar is held. (See Tables VIII. to XI.)

A comparison of Tables VII. and VIII. will show the results of crushing steel bars 3 inches long and 8 inches long.

All test-pieces in Tables VII. to XI. having the same name are cut from the same rolled bar of soft steel or Swede iron.

Table IX. shows the tensile strength of the same test-bars.

Tables X. and XI. show that testing-bars with 8 inches on which to measure extensions of compression and held in the same grips show the tensile and crushing strength much better than by using shorter test-bars.

Microstructure of Cast Iron.

In each cast, or series, a number of test-bars of one square inch section, some square and others round, were made in molds and of iron of as uniform quality as would be possible in any foundry.

Some test-bars of 1.13 inch diameter

TABLE VI

Crushing of Columns.	Maximum Load per □″.	Length at Max. Load.	Compression per 1,000 lb.	Compression per inch per 1,000 lb.
1″ □ × ¼″ long	*112,700	0.38	.001064	.002128
1″ □ × 1″ long	*96,420	0.87	.001347	.001347
1″ □ × 1½″ long	*93,030	1.37	.001307	.000931
1″ □ × 2″ long	*80,600	1.85	.001861	.000930
1″ □ × 3″ long	† (79,700) * 76,000	(2.83) 2.90	(.002183) .001316	.000711 .000438
1″ □ × 4″ long	78,850	3.77	.002662	.000665
1″ □ × 8″ long	‡63,380	7.72	.004419	.000552
1″ □ × 12″ long	§47,570	11.80	.004304	.000359

*Short column fracture; all others long column fracture. † This record should have been about 79,700; the piece was defective. ‡ Began bending at 48,000 lb. § Began bending at 43,000 lb.

TABLE VII.

Crushing Steel, Test Pieces 3″ Long.	At Yield Point. Load per □ in.	Length at Load.	Compression per 1,000 lb.	Crushing Load. Load per □ in.	Length at Maxim'm Load.	Compression per 1,000 lb.
1″ ○ soft steel	34,283 35,495	2.95 2.90	.001786 .003449	69,232 69,008	2.57 2.58	.007602 .007432
1″ □ Swede iron	36,000 36,000	2.98 2.97	.000555 .000833	100,000 75,200	1.85 2.40	.010500 .007979
1″ □ soft steel	38,000 36,000 36,000	2.95 2.99 2.98	.001316 .000279 .000555	80,460 84,900 75,600	2.60 2.52 2.69	.004971 .005654 .004101

TABLE VIII.

Crushing Columns, Steel Bars 10″ Long, Compression in 8 Inches. Held in Grips.	At Yield Point. Load per □ in.	Length at Load.	Compression per 1,000 lb.	Maximum Load. Maximum Load per □ in.	Length at Maxim'm Load.	Compression per 1,000 lb.
1″ ○ soft steel	33,111 33,111	7.99 7.99	.000375 .000375	35,778 38,197		
1″ □ Swede iron	22,000	7.99	.000284	25,500		
1″ □ soft steel	34,000 34,000	7.99 7.99	.000348 .000348	44,200 * 41,000 *		

* At 36,000 buckling and scaling were very plain.

were tested transversely and in tension; all 1″ □ bars were tested transversely and a complete chemical analysis was made of all sizes of square test-bars.

The photo-micrographs (Figs. 5 to 9) of the center and edge were made from a specimen cut from test-bar No. 43, 1.13″ diameter, and Figs. 10 to 15 of the corner side and center were made from a specimen cut from one of the 1″ □ test bars, all from Series 2.

Series 15 (and 13) was a regular high silicon stove-plate mixture of 80 tons per day.

Series 18 was in 1894 considered the best mixture for heavy machinery of Messrs. Bement, Miles & Co., Philadelphia, Pa. For a description see *Transactions*, vol. xvi., p. 1078. Figs. 34 and 35 are from the center of the test-piece .692″ diameter. Figs. 36 to 43 are ½″ from the edge of the test-bar.

Series 19 was in 1894 a good car-wheel mixture of Messrs. A. Whitney Sons of Philadelphia. Figs. 44 and 45.)

Mild steel (Fig. 47) is from the square bars of Tables VII. to XI.

Report of Professor Albert Sauveur.

Photomicrographs were made by Mr. Boylston of the unetched surfaces because such surface shows the graphite particles better than an etched surface, and the mode of occurrence of graphite particles has a marked influence upon the properties of the iron.

In order to justify inferences arrived at in every case it will be well to bear in mind the two following propositions:

First. *For a given composition* of cast iron the smaller the particles of graphite the stronger the iron.

Second. *A cast iron of maximum strength* should have a metallic matrix of maximum strength, and this means that this matrix should consist only of pearlite or should contain but a slight excess of cementite, which in turn means that the proportion of combined carbon should be somewhere between .7 per cent. to 1.00 per cent.

There is no marked difference in structure between the center, the edge and the corner, nor is this to be expected because the rate of cooling of so small a bulk of iron, cast in sand moulds, should not vary much.

In the specimen from bar 59.692″ dia. of series 15 the difference between the combined carbon reported by the chemist and as indicated by the structure is extreme. The chemist reports for a test-bar **5 □ .10 per cent. of combined carbon** while the structure shows about .4 per cent.

It is very surprising that notwithstanding this low amount of combined carbon and the fact that the graphite particles are quite coarse, the tensile strength of **bar 59 is 24,400 lbs. per □″. As shown** from the structure, we should have inferred that it would have been considerably below 18,000 lbs. per sq. inch.

It should be borne in mind that the specimens of cast iron which were subjected to a microscopical examination were neither those that were analyzed nor those that were subjected to the physical tests. It is not to be expected, therefore, that the photomicrographs which we here reproduce correspond to the structure of the bars actually tested, neither do they suggest accurately the chemical composition of these bars. Try to infer the physical or chemical characteristics of samples of cast iron from the structure of *other samples*, although cast at the same time and under the same conditions, would be a very hazardous proposition, and it is why it was not attempted in this report.

TABLE IX.

Columns in Tension, Steel Bars 10" Long, Extensions in 8 Inches. Held in Grips.	At Yield Point.			Maximum Load.		
	Load per □ in.	Length at Load.	Extension per 1,000 lb.	Maximum Load per □ in.	Length at Maxim'm Load.	Extension per 1,000 lb.
1" ○ soft steel.....	34,380	8.06	.002222	50,840	9.81	.035602
1" □ Swede iron ..	20,000	8.02	.001020	41,900	8.46	.04177
1" □ soft steel. ...	32,000	8.01	.002453	58,370	9.90	.03255

TABLE X.

No. of Series.	Crushing Tests. (1 □" area, 8 in.)	% C[d].C.	% Si.	Compression at Load of 14,000	16,000	22,000	Maximum Crushing Load.
	□ Soft steel	.....	0.	.00295	.00345	.00490	44,200
17	○ White cast iron	2.85	0.81	.00400	.00465	.00645	123,520
19	○ Carwheel iron.....	0.99	0.72	.00570	.00650	.00955	61,211
18	○ Heavy machinery	0.52	2.09	.00330	.....	.....	.....
13	○ Stove plate iron	0.10	3.22	.00730	.00855	.01325	48,960

No of Series.	Tensile Tests. (1 □" area, 8 in.)	% C[d].C.	% Si.	Extensions at Load of 14,000	16,000	22,000	Maximum Tensile Load.
	□ Soft steel	.....	0.	.00305	.00365	.00525	58,370
17	○ White cast iron	2.85	0.81	.00400	.00460	.00645	24,000
19	○ Carwheel iron.....	0.99	0.72	.00310	.....	.....	30,000
18	○ Heavy machinery	0.52	2.09	.00500	.. ..	.....	24,000
13	○ Stove plate iron.....	0.10	3.22	.01460	.01995	....	16,850

TABLE XII.

Prof. Sauveur's Microanalysis.

No. of Series.	No. of Test Bar.	No. of Figure Photomicrograph.	Size of Test Bar.	Condition of Graphite Particles.	Apparent % of C[d].C.	Tensile Strength per □ From Structure.	Tensile Strength per □ Prof. R. C. Carpenter's Test.
1	22	2, 3, 4, 46	1.13"○	Small and fine.	.80	Exceed 20,000	15,700
	43	5, 6, 7, 8, 9	1.13"○	Finely divided.	.80	" 20,000	22,500
2	.....	10, 11, 12, 13, 14, 15	1"□	Quite coarse.*	.80	" 20,000 (but less than 22 & 43)	
3	65	16, 17, 18	1.13"○	Relatively coarse.	.60	Less than 20,000	20,450
4	87	19, 20, 21	1.13"○	Smaller than 65.	.60	" " 20,000	19,350
5	109	22, 23, 24	1.13"○	Small.	.40	" " 19,000	19,750
6	131	25, 26, 27	1.13"○	Very coarse.	.45	" " 18,000	17,900
15	59	28, 29, 30	.692"○	Quite coarse.	.40	" " 18,000	†24,400
	307	31, 32, 33	1.13"○	Medium.	.10	" " 17,000	20,300
18	67	34, 35	.692"○	Small and fine.	.70	Exceed 20,000	
	65	36, 37	1.13"○	" " "	.70	" 20,000	24,110
	338	38, 39	2"□	Very coarse.	.20	Less than 15,000	
	340	40, 41	3"□	Coarse.	.25	" " 16,000	
	341	42, 43	4"□	Very coarse.	.15	" " 14,000	
19	73	44, 45	1.13"○	Coarse.	1.10	Exceed 22,000	31,545

Mild steel, 47.

* No marked difference in the appearance of the grain at the edge and center of a round bar or the corner side and center of a square bar.

† The photomicrograph was from the sample that was tested in tension, therefore in this case a comparison can be made.

The disagreement which exists between the structures here shown and the results of the physical test and the chemical composition of other bars is not to be wondered at considering the difference which generally exists between test-bars cast under identical conditions and from the same heat.

Note by W. J. K.—In Table xii the tensile tests by Professor Carpenter and the two footnotes, and Table xiii are not a part of Professor Sauveur's report.

It was hoped that the photomicrographs would explain variations in the records of physical properties and further examination may do this to some extent.

It was thought that a comparison of the crushing tests of this paper with the tensile tests previously made would show the relation between extension and compression for varying percentages of Silicon, but the crushing of short cylinders fails to show this; and the very satisfactory tests shown in Tables viii to xi were made on long test bars held in grips with 8 inches on which to measure changes in length.

It is expected that an apparatus will be perfected that will simultaneously make autographic diagrams of transverse load and deflection, and of elongation and compression of the extreme fibres; and that from this data can be calculated by a formula the position of the neutral axis and the crushing and tensile strength. Probably these results can be presented to the Society in the near future.

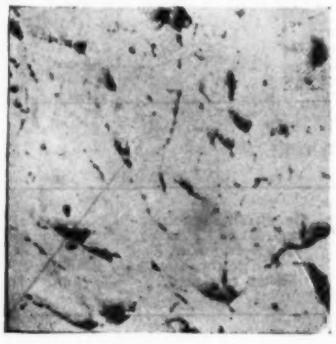


FIG. 2.

FIG. 3.

TABLE XIII.

Chemical Composition for Comparison.

No. Series.	Size Bar.	T. C.	G. C	Cᵒ. C.	Si.	S.	P.	Mn.	Transverse Strength per □″.
Iroquois		4.05	3.20	0.87	.98	.035	.225	.49	Mixed to make Series 1 to 6.
Pencost...		2.79	2.04	0.75	10.00	.015	.487	.67	
1	1″ □	3.85	2.60	1.25	.79	.054	.213	.36	2,025
2	1″ □	3.86	3.32	.54	1.14	.040	.269	.30	2,046
3	1″ □	3.75	3.28	.45	1.73	.030	.267	.51	2,540
4	1″ □	3.72	3.24	.48	1.69	.046	.283	.30	2,410
5	1″ □	3.56	3.40	.16	2.65	.021	.330	.39	2,464
6	1″ □	3.46	3.08	.38	2.69	.033	.299	.45	2,214
15	.5″ □	3.13	3.03	.10	3.29	.088	.980	.50	3,392
	1″ □	3.10	3.01	.09	3.50	.090	.975	.49	2,235
18	.5″ □	3.35	2.90	.45	2.29	.052	.340	.35	3,568
	1″ □	3.35	2.83	.52	2.09	Drillings of all sizes of test bars were mixed and analyzed in Series 18 and 19.			2,290
	2″ □	3.30	3.06	.24	1.82				2,000
	3″ □	3.23	3.11	.12	2.06				1,877
	4″ □	3.31	3.20	.11	1.88				1,835
19	1″ □	3.85	1.86	.99	.72	.101	.353	.35	2,880

Chemical determinations by Messrs. Dickman & Mackenzie, Chicago, Ill. It was intended that Series 1 to 6 should contain 1.00, 1.50, 2.00, 2.50, 3.00, 3.50 per cent. silicon, but no excess was added for loss in melting. Other discrepancies are due probably to uneven diffusion.

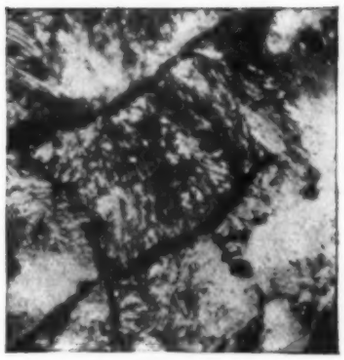


FIG. 12.

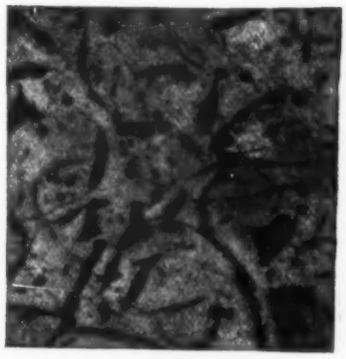


FIG. 13.

FIG. 4.

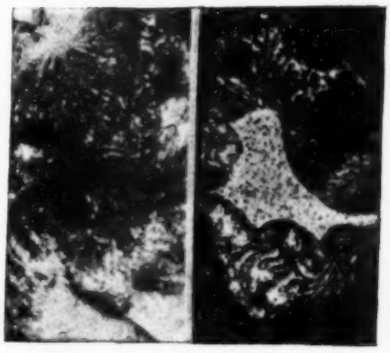
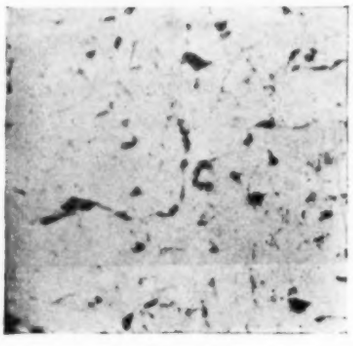


FIG. 8. FIG. 9.

FIG. 14.



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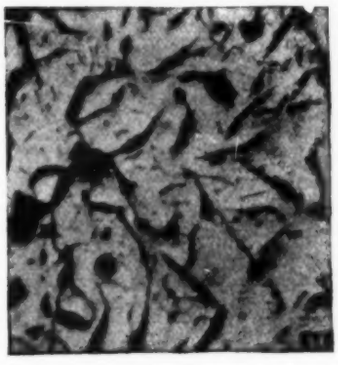

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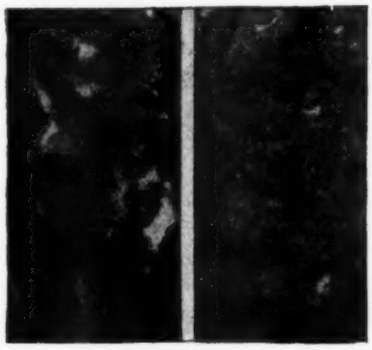
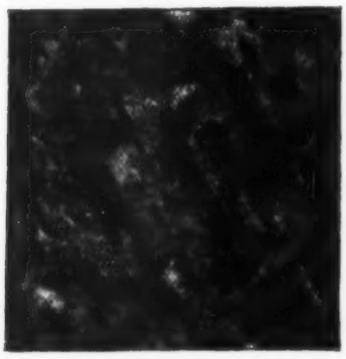


FIG. 6. FIG. 7

FIG. 11.



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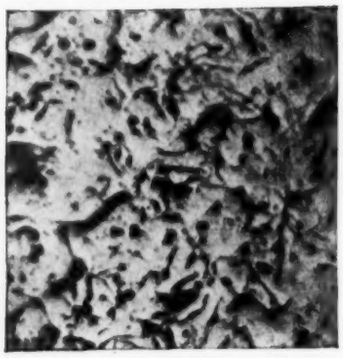

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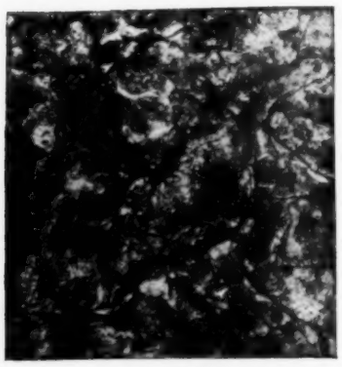

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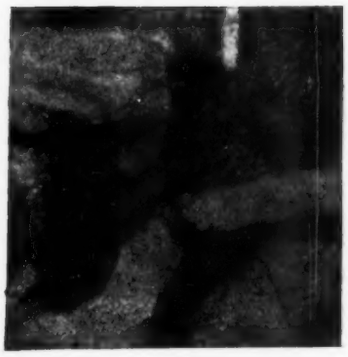
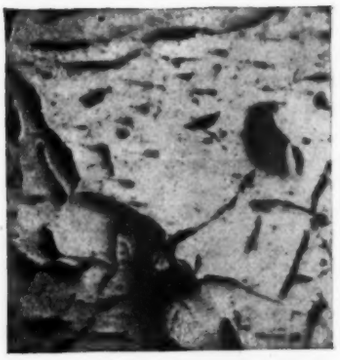


FIG. 24.

FIG. 17.

FIG. 21.



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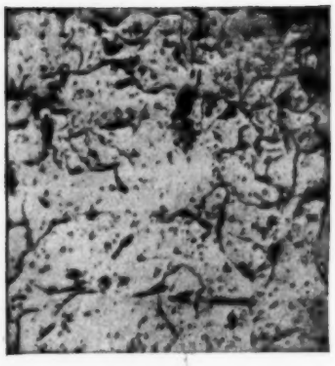

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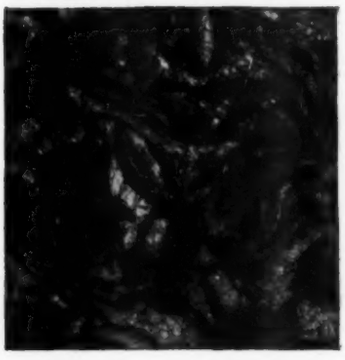
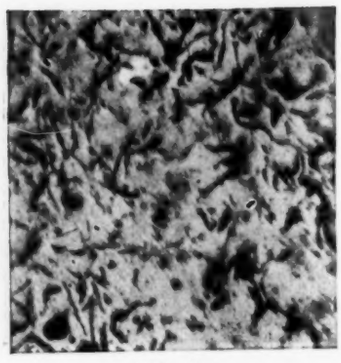


FIG. 26.



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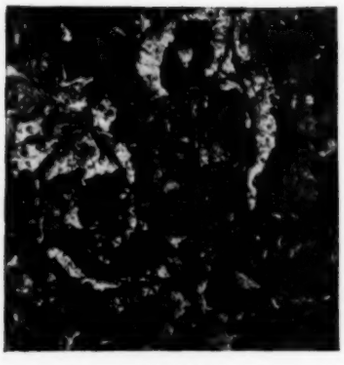

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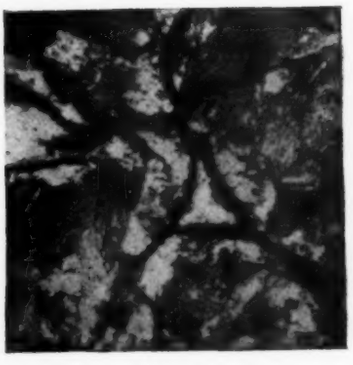


FIG. 27.

FIG. 28.

FIG. 32.

FIG. 36.

FIG. 29.

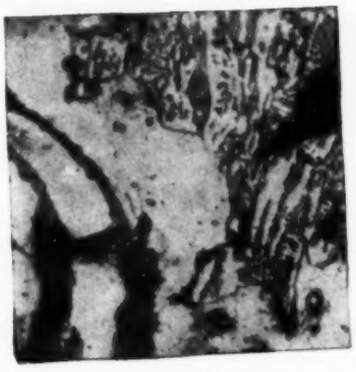
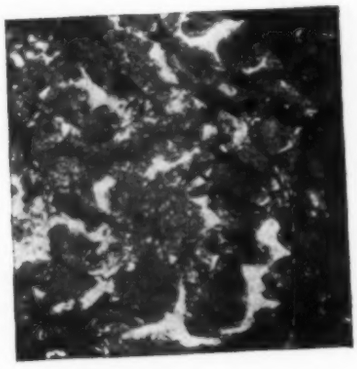


FIG. 33.



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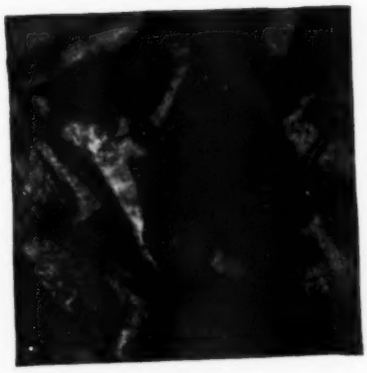

FIG. 30.

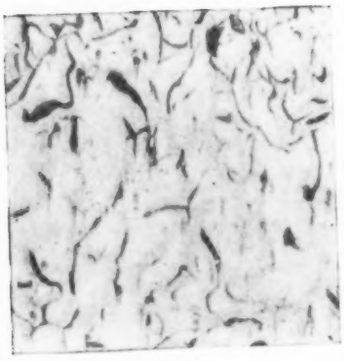

FIG. 34.

FIG. 38.

FIG. 31.

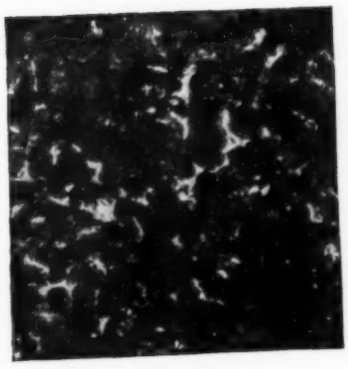

FIG. 35.

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FIG. 41.

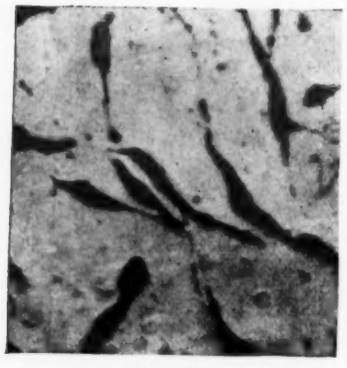


FIG. 42.

FIG. 43.

FIG. 44.

FIG. 45.

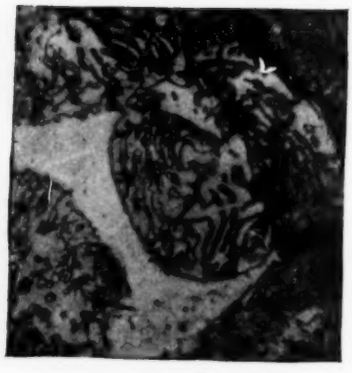


FIG. 46.

FIG. 47.

Letters to the Editor.

Cutting a Long Square Thread Screw without a Lathe or a Die, and Utilizing the Scrap Pile.

It is easy to see that Dixie is a man who would get out of almost any kind of a hole. His account at page 94 of how he cut that long screw shows that.

It also shows that he has a positive talent for the commercial end of the job-shop business. I know from experience that one of the first requisites necessary in running a job shop successfully is to get the reputation of being able to do everything. When it is well known that every job that comes will be done some way, work will come a long ways even in a country where shops are not as scarce as they likely were in the Argentine Republic.

After a man gets the work in, it is the commercial end of it to do it at a profit. Dixie seems to have had this part of it figured down fine. He used just as much of his scrap heap as he possibly could. By doing this he made the job look mysterious, and at the same time made the job last longer. Both of these things were to his advantage. The first one added to his prestige as a mechanic, and the last one added to his pocketbook. He does not tell us how much he got for the screw when completed, but when a man has to fetch and deliver 30 miles on horse-back I think he would have time to see and add to the bill the full value of every bit of scrap used.

Now, if I had been called upon to do that job, as like as not I would have left the left-hand screw at the estate and only taken the stripped one with its nut to the shop with me. As there was 8 feet of thread on the screw and only 18 inches of it stripped I might have used the nut on the best end of the balance of it for a feed. A sleeve with two set crews would serve to couple the old screw and the piece to be threaded so that they would form a continuous piece. A log, plank, or the shop floor, if the bench could not be used, would have done instead of his long and wide channel which chanced to be at hand, and any kind of a piece of iron, wood or babbitt might have served to keep the tool from crowding the shaft away. I can imagine myself, with a lever clamped to the end of the screw, sweating away while I took a cut as long as the good part of the thread on the old screw would allow. Then I would loosen the coupling, screw back my lead screw, move my tool post and back rest along with the screw being cut, so that I could couple up again, and fasten down my cutter and rest and go ahead.

I would only be providing the tool-post carriage, the back rest, a sleeve coupling, a lever for a handle, means for fastening the feed nut, back rest and tool holder in

place, and a place to fasten them, and likely my screw when cut would not be any too good for the hay press, but it would be some better than no screw at all. With that inexhaustible scrap pile at hand I do not claim that my way would be as good as the one used by Dixie, but it will show what might have been done with different conditions.

There is a point, which the scrap pile brings to mind, which perhaps Dixie or someone else who has had experience in running a job shop can give me some light on as showing the custom in other places.

Ordinary practice in this section seems to be like this: if a man brings a piece to have a new one made like it and does not take the old one away with him, it is put into the scrap pile and used or sold according to what it may be good for; but the man who brought it does not get anything for it. The same thing holds good if parts of a machine brought in for repairs have to be replaced, or if a man brings the material for the job and not all of it is used. He is free in all cases to take his old pieces or his surplus stock with him when he gets his job; but, failing to do that or to say anything about it, it is kept and no credit given. Of course where the piece being replaced, say a cylinder or flywheel for instance, has considerable value for the raw material in it the owner generally either takes it away, or if the shop has also a foundry, sells it to them.

This matter was called to my attention some time ago by a friend of mine who runs a little job shop. He had done a lot of repair work for a firm in which there were several partners. This work had been anything needed and had extended over several years without any serious disagreement.

One of the quite common jobs was to make a new valve stem for a valve. The firm in question used a great many valves with brass valve stems and it was the common practice of the job shop to make a new valve stem from a worn-out one from a larger sized valve. Where the valve body failed, the brass stem would be taken out and put into the brass scrap by the firm and often in sending down a single valve they would send one of these old stems along to be used in making the new one. One of the partners who had not before been active in the management of the business began to spend his time around the works and discovered the "robbery" being practiced by the little jobbing shop. He demanded restitution not only for the old stems which had been taken out of repaired valves and not used in other ones, but for the waste pieces and the chips, and it looked for a time that a law suit would result from the difference of opinion.

In my own practice I never had but one man demand the chips. He spoke of it when he ordered the work done and expected to get the difference between the weight of the castings and the finished work. I had him stand around a few minutes with a man turning brass at a good speed; he then made up his mind that it would take more time to save all of the chips than they were worth, and that the amount saved from an ordinary job, without going to too much trouble in cleaning up so as to be able get them and have them clean, was not worth fighting over.

Theoretically it might seem that the man getting a job done should receive credit for all the scrap, but it must be remembered that as far as he is concerned it is only scrap, and to keep track of it and credit him with it means also to charge him with the time necessary to do it and in the end the balance would be more apt to be against him than for him.

Here is an old piston rod and head. Together it weighs 37 pounds. Before it could be sold it must be broken, as the head is cast iron and the rod either wrought iron or steel. After the head is broken off it may weigh 20 pounds and be worth 9 cents, and the rod may weigh 17 pounds and be worth 5 or 6 cents. If the sledge can be hunted up, the head broken off, the pieces weighed and the amounts turned into the office for 15 cents' worth of time charged up against the job by the machinist, it will be a very exceptional shop. If the foreman has to keep track of the pieces left from a job and have a helper do the collecting, breaking and weighing, it will cost even more than having the machinist do it.

It is true that the rod may come in for some other job, and be charged for, as though it were new stock for as much of it as is used, but it cannot be saved on that basis. Dixie's "inexhaustible" scrap pile illustrates that. However he was getting it, he was likely using every effort to use it up, and still could not keep ahead. We must admit that if he could not keep ahead of a scrap pile we ordinary mortals do not stand much show to do so.

W. OSBORNE.

An Erasing Machine.

The drafting department of the Laclede Gas Company, St. Louis, keeps records of streets, plat books, insurance books, main records, etc., and as these records must be continually changed on account of new pipes being laid in place of old ones, there is a great deal of erasing to be done.

To reduce the large amount of time and work necessitated in erasing by hand and yet permit of the work being done carefully, the following scheme was devised to do this erasing mechanically.

An ordinary dental engine, such as is used by dentists for drilling teeth, was procured, and a circular ink eraser attached to the chuck by means of a small screw. The flexible shaft to which the eraser is attached allows considerable movement, and all the draftsman has to do is to guide the eraser by means of the handle. Anyone trying this machine should watch the following points:

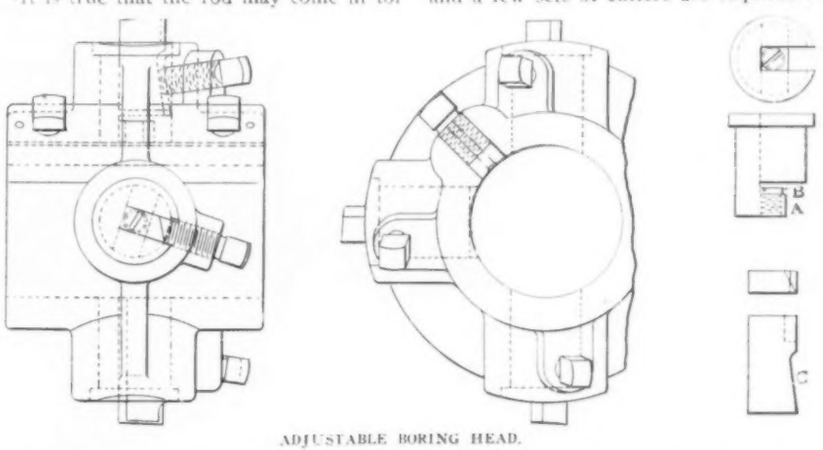
Keep the machine at a good speed, and do not press the eraser too hard into the paper, as it erases very rapidly. It will be found that a good paper will take on a hard surface at the erased place and the erasure will be hardly noticeable.

Erasing can be done with this machine in about one-tenth the time it would take to do it by hand; besides it is not tiring to the draftsman.

HERBERT S. GLADFELTER.

Adjustable Boring Head.

The drawing shows one of a number of adjustable cutter heads for boring bars, with interchangeable bushings for holding the cutters. One set of bushings and a few sets of cutters are required for a wide range of work on a boring mill when equipped with various sizes of cutter heads of this style. The head is made of gray iron, and contains four holes to receive the bushings. It is clamped in any position on the bar suitable for the work by two set screws bearing on a tool-steel shoe. The shoe is held in place by two dowels which are driven into the head and fit loosely in the shoe, the holes in the latter being counter sunk for the small heads made by riveting the ends of the dowels.



ADJUSTABLE BORING HEAD.

The bushings are made of tool steel, and contain slots 7/16 inch wide and 15/16 inch deep, for receiving the cutters, which

are machined from ½x1-inch tool steel. The heel *A* is drilled and tapped ⅜x16 thread for the snug-fitting adjusting screws *B*. When making a set of cutters, the heads of the adjusting screws are brought down tight on the heels of the bushings, and when in use and adjustment is required the screws are backed out. One-eighth of a turn of the screws will adjust the cutters to bore 1/64 inch larger, and a full turn will set them to enlarge the bore ⅛ inch. In these heads as designed, the range of adjustment for one set of cutters is half inch in the diameter of bore.

The contact face *C* for the set screws on the cutters, is made angular, so that when the screws are tightened the cutters will be forced downward and backward to their seats. The set screws for clamping the cutters, and those for clamping the head, are made of tool steel, and have flat points which are hardened and tempered blue.

H. E. R. MANBRAND.

Die Beds or Bolsters for Press Dies.

At page 423 Mr. Lucas brought up the subject of die holders and the style mostly used in general practice. In my experience I have found that there are not many shops having a standard set of die beds to suit dies made to a standard size to meet the requirements of the different sizes of blanks that have to be made. As soon as a job comes in, the question arises, "What bolster can we put this job in?" When the matter has been looked into it is found that there are several very near the thing, but either not wide enough, or the length or the hole is not quite large enough, and the consequence is another die bed has to be made. The pattern is made to suit the present job with perhaps no thought that the next job might want one a little larger. The same thing goes on till there are many patterns lying about in the pattern room, of practically no use to anyone, as they were each made for one particular job, where they might each have been made to suit a number of different ones. I would suggest that die blanks should be machined to some standard size suitable for blanks varying up to about 1½ inches, another size up to 2½ or 3 inches, and so on up to the largest. Have some of the die beds cored round, some square and some oblong in the holes, so as to suit special-shaped blanks. In some cases it is advisable to have them solid and drilled to suit. I also suggest that more use be made of steel-faced iron, as it is easily worked, will not burst open and crack in hardening, and I have found it not so liable to distortion in hardening. The steel should be at least ⅜ to ½ inch thick; that is, the iron should be faced with steel about ½ inch thick, as when a die is worn out and ground away ⅜ inch it has done its work and lost its shape more or less, so by having the iron underneath it the steel is supported till it is practically used up.

In one of the engineering works where there were a large number of dies made for electrical machine parts, such as stator and rotor blanks,—the dies and punches were built up in sections of 2½-inch square cast steel forged nearly the shape, then machined. Through my suggestion they got some steel-faced iron in place of cast steel, using the steel face for the cutting edges. It was easier to forge and machine, kept its shape in hardening, and I believe was used to advantage.

I send you sketches of die holders which may be of interest. My objection to die-setting is the use of liners or packing except in some cases under the die, as when the die is ground it has to be packed up to raise the surface above the die bed.

Fig. 1 is a die bed with the die held in by a key tapered 1 degree. It will be noticed that the die bed is machined with two different angles. The side the die lies against is machined at an angle of 10 degrees, the key side is 12½ degrees. The die is machined at an angle of 10 degrees on both sides; one side of the key is 10, the other 12½ degrees, so as to fit the die bed. When driving it in place it will have a natural tendency to force the die down flat. I always use a key *A* to locate the dies on one side of the bolster, as the die can be taken out and put back without disturbing the punch. One shop I was in the dies were driven into separate bolsters without keys.

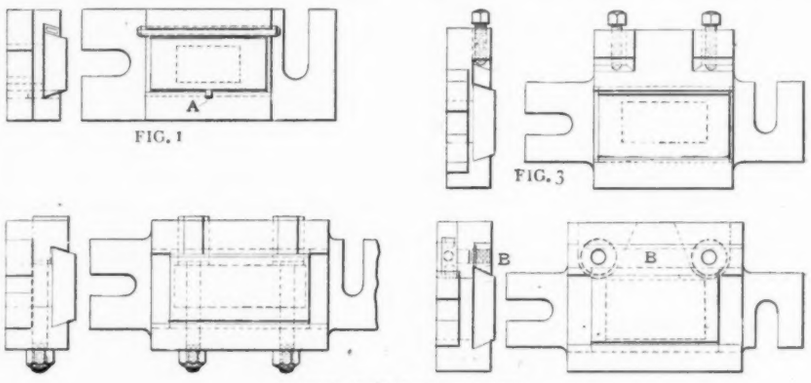


FIG. 1 FIG. 3

SECURING DIES IN BOLSTERS.

Fig. 2 is another style of die bed, which I have never seen in use. For holding small dies it is just the thing, handy, and the dies are easily put in and taken out. There is nothing to get lost as there are no loose pieces to get mislaid. It should be made of mild steel if for heavy work, but for light work gray iron will answer as the bolts help to keep it together. It is machined in the usual way and then slotted for two dovetailed headed bolts which go through the bed and drawn up with hex nuts gripping the die. The bed is cored with an oblong opening for the blanks to fall through.

Fig. 3 is another style of bolster with a dovetailed slide which clamps the die. This die bed should be made of mild steel as the pressure from the screws is liable to burst it. It is provided with an oblong opening for the blanks to drop through. The locating key I have not shown but it is generally used as it is very convenient. Fig. 4 is a handy die bed made of mild steel with the gap for the die made wide enough for a gate *B*, which is machined the angle of the die on one side, the other side being left straight. It is clamped by bolts, made either with hex heads or tommy holes to be screwed up with a pin. If hex nuts are used the space underneath can be machined right across the bed so as to make room for the wrench. Die beds of this kind where the dies are made to interchange should be made of mild steel as they will better stand rough usage.

If anyone is thinking of starting a press shop I advise him to start at the beginning and have die beds properly designed to take dies of standard size for each bed, as it will pay to have a system of standard dies, and thus avoid having to fiddle about with liners, packing, odd bolts and straps trying to make a die fit a bed which was never intended for it. Have a standard size for your dies, have as many sizes as your work demands, but have each size to gage; then have a die bed to fit each of the different sizes and it will make the press room hum as it should do. There is no advantage in doing a job on a press in 10 minutes if it takes an hour to set it up.

London, England. C. PETITJEAN.

Cast-Iron Beams.

It may seem a little odd for me to appear as a champion of text books, but I like to see everyone get all the credit there is due him.

Mr. Osborne's article at page 832, Part 1, dealing with cast-iron beams, reminded me that I had to look up something of the sort 10 years or more ago. I went a little deeper into the book end of the proposition, for I was brought up on the idea that these hand books are for the convenience only of men who already know the whys and wherefores of engineering, and that these whys and wherefores are to be found, if at all, in text books and treatises on the subject under consideration. Text books have a way of being lame on

most points that a man really wants to know, but on this subject they are fully up to the practical man's work. Take Rankine; his book is prefaced 1858. He quotes Barlow in tests made in 1855 as finding that the modulus of rupture (or breaking stress per square inch, if you prefer) varies from the ordinary tensile strength of cast iron (if anybody knows what that is) up to two times or more that amount. The suggestion was made at that time that the difference was caused by the extra strength of the chilled surface or skin; but this has been apparently disproved by more recent tests, which tend at least to show that the effect of this hard surface is so small as to be overshadowed by other considerations. Robinson and Segrendo reported in the proceedings of the Institute of Civil Engineers, Vol. 86, a variety of tests, among which were some on bars of circular cross section which showed a higher average strength for turned bars than for rough ones. To meet this condition it has been suggested that the initial stresses due to unequal cooling, due in turn to the shape or manner of molding of the piece, may have an effect which may be either favorable or unfavorable. This is on the same principle as the Rodman gun, in which the part which must have the greatest tensile strength in use is put under heavy compression when at rest; so that a small charge of powder will only have the effect of neutralizing this compression and a large charge may only produce a resistible tension in this part. So if Mr. Osborne's bars which he tested head down have an initial stress of compression in the head of the tee, then any weight placed on the bar would have to neutralize this compression before it could produce its normal effect on the bar, and consequently the bar would carry a greater load than he expected.

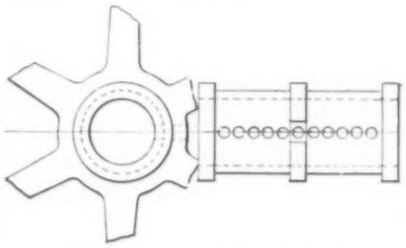
Another reason for the discrepancy between the action of cast iron and steel appears in the way the modulus of elasticity runs. The modulus of elasticity is the result obtained by dividing the stress put on a bar one inch square, by the stretch or compression per inch of length, which it causes. It so happens that for light loads this modulus of elasticity is practically the same for both tension and compression, so that for light loads the rules of the hand books may be safely followed in getting the probable deflection of these beams. But as more pressure is applied, the modulus of elasticity falls off; but faster in the case of tension than in the case of compression, which is natural since we know that the ultimate strength of cast iron is greater for compression than for tension. Either or both of these explanations may be the true one; they are not incompatible; but the final word of the text-book man is this: that if practical men will furnish him with castings whose strength is uniform, that is, a succession of castings from the same pattern which will carry the same load within a few per cent., he will give us something from which we can calculate the probable strength of other beams of other forms. Every professor of mechanics and a large number of students have had a try at this and have had to give it up in disgust, just because no two pieces of cast iron are alike. It is worse than the old problem, "How big is a lump of chalk?" If Mr. Osborne will have another set of bars cast in another foundry in molds made by another workman it is quite possible that there may be such a difference in the results of the tests that no one would suspect that the castings were off the same pattern. There are so many unknown quantities that enter into the make-up of a casting: variation in the ramming of the mold, the temperature at which the iron is poured, the dampness of the sand, relative thickness of parts, position of the gate, hight of riser, amount of sand around the iron, how soon it is uncovered, etc. All these things and more go to produce variations in the strength of the result. Cast iron is curious stuff anyway. As an absorber of vibration on the anvil principle and for window weights it has no superior. In light sections or suddenly varied sections it is peculiarly susceptible to jars. I remember hearing of a case where they found that the easiest way to break the necks from rolls was to drop a weight on the farther end of the roll, when the neck would quietly drop off. The safe rule, and one which naturally follows from reading of text books as well as of castings, is never to use cast iron in places where it is necessary to compute its strength. If it is not possible to use enough so that it is far and away stronger than it is computed to need to be, better use something else.

When you take a pattern to the foundry and order a casting, the only thing that you have any right to demand of the founder is that it shall be "sound and true to the pattern." You don't know and he doesn't know, and nobody else knows how strong it will be. Whether it is worth while to know is an open question, but if there were some way of producing castings of even approximate uniformity it might extend the use of cast iron into various channels where it has once been but from which it has now been driven by its vagaries. ENTROPY.

Loose-Pulley Oil Holes.

When a pulley sticks and keeps sticking, I drill a quarter-inch hole through the hub parallel with the oil groove and plug up the ends. If there are not oil holes on both sides of the hub I drill one directly through the parallel hole just drilled to the shaft and stop up the outside of one hole. The object is to convey oil to both sides of the hub, which when the oil groove is clogged will flow through the parallel hole.

A loose pulley which will not stick and gives excellent satisfaction with high or low speeds is made in the following manner: A composition bushing with three ribs, the center one cut through as shown in the illustration, is turned a driving fit for the pulley. Between the ribs a line of holes is drilled as close together as possible; these are filled with leather or felt punchings made with the common belt punch. When this bushing is driven in place it gives an oil chamber large enough to hold oil for months. Sufficient



BUSHING FOR A LOOSE PULLEY.

oil is transmitted through the felt or leather plugs to lubricate the pulley. The leather plugs do not glaze and convey sufficient oil. F. H. SANDER.

Correct Shape of Lathe and Planer Tools.

In designing tools for the lathe, shaper and planer, to have the greatest strength with a minimum of material is a point too often overlooked. A tool is ordered, "to be extra strong." How often have we seen the tool returned shaped as in Fig. 1; a very poor design, but little better or stronger than that as shown by the dotted lines, for the fullness is below the fillet.

The tool should be made as in Fig. 2, the fullness at the fillet, shaped to the general scientific proportions of the beam; if not so formed, the tool, when crowded, in fracture will lose a maximum amount of material; if properly proportioned, but

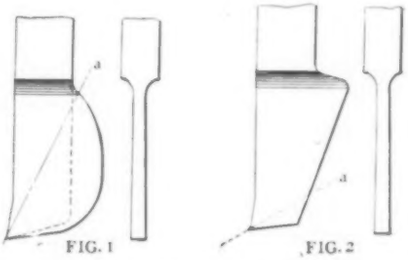


FIG. 1 FIG. 2

FORMS OF LATHE AND PLANER TOOLS.

a minimum quantity of steel will be lost. The line of fracture lies near the line *a* in both views. F. RATTEK.

We note that the *Daily Consular and Trade Report* prints the plural form of terminal as *termini*. We wonder why terminals won't do. It answers for all the other publications we know of, and the literature of the science of electricity and of railroads is full of "terminals."

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An Old Testing Machine.

At a recent meeting of the British Institution of Mechanical Engineers, J. Hartley Wicksteed read a description of a recent testing machine designed by him, which is the largest in England, and which approximates in power the Emery machine at the Watertown Arsenal. In connection with this description Mr. Wicksteed gave illustrations of what he declares to be the first testing machine ever made, which combined the same essential principles as the most approved modern machines, namely hydraulic power for straining the specimen and dead weights acting through levers with knife-edge fulcra for measuring the load. Considering its date the machine had the remarkable power of 130 long tons. The machine was made in 1829 at the Cyfarthfa Iron Works of Merthyr Tydvil, Wales, from designs by William Williams, then engineer of the works. By a remarkable coincidence, the latest machine by Mr. Wicksteed has been installed in the same locality as the old machine which he describes.

The original drawings of the old machine have been preserved by the son of its designer, and from them Mr. Wicksteed's illustrations are reproduced, their publication by him being the first that has been made, and it is a striking illustration of the engineering judgment of the designer of the old machine that it should have been based upon essentially the same principles as those now used.

The machine is of the vertical type, and appears to have been arranged for testing in tension only. Two upright frame columns are formed into hydraulic cylinders at their upper ends from which project the rams which are connected by a crosshead to which the straining shackle is attached. The bottom shackle lifts a lever of the second order connected to a second lever on the end of which dead weights are placed. This second lever, which answers the purpose of the ordinary scale beam did not carry a sliding poise, the weights at its end representing the smallest increment of load. Mr. Wicksteed points out further that the old machine had precisely the same arrangement for taking care of the rebound due to the fracture of the specimens that he uses in his recent machine, and he adds that the chief fundamental improvements which the latter machine exhibits over the former, lie in the provision of the poise and of a movable straining head locked in a sliding frame.

A Remarkable German Locomotive.

A recent issue of the *Mechanical Engineer*, of London, contains an illustration and some particulars of a remarkable locomotive which has just been completed by J. A. Maffei, of Munich, for the Bavarian State railways, and which has been designed for hauling passenger trains at a speed of 94 miles an hour in normal running. The machine is of the 4-4-4 type, the trailing wheels being mounted in a bogie, as are the front wheels. The engine is compounded and balanced, the low-pressure cylinders being external to the frames, and the high-pressure cylinders between the frames, the former acting, of course, on crank pins in the forward driving wheels and the latter on cranks in the axle of the same wheel. These cranks being opposite to one another, an almost perfect balance is secured. The valve gear is of the Walschaert type, and the disposition of the cranks is such that a single gear actuates the valves for both the high- and low-pressure cylinders of each side of the engine. In several respects the engine has a decidedly American appearance, notably in the use of bar frames, the bogie truck, and a well developed cab, as well as an extended front and a wide fire-box in the rear of the driving wheels. The boiler has a conical front, and the boiler mountings and cab fronts are similarly designed to reduce the resistance of the air. The engine is fitted with a Schmidt superheater. The total weight of the engine is 81½ metric tons, the boiler has a total of 2217 square feet of heating surface, while the cylinders are 16⅛ and 24 inches in diameter respectively, and the driving wheels are 7 ft. 2⅝ inches in diameter. We infer that the engine has not yet been put in service, and, at any rate, particulars of its performance are lacking.

American machinery men will be especially gratified to know that Sir William Mather who is at the head of the firm of Mather & Platt, well known engineers and machinery constructors in Manchester, has testified before a committee of the House of Lords to his firm faith in the honesty of American business men generally, and has opposed making any exceptional arrangement for British policy holders in American insurance companies. We hope Mr. Mather's confidence is well placed, but doubt if American companies are generally managed with as careful consideration for the rights of stockholders as is usually the case in Great Britain. This is probably not due to an inherent inferior degree of honesty, but to the fact that corporations are generally more thoroughly safeguarded in England than here. They will be better safeguarded here probably, and in the meantime let us all remember that whatever of unpleasantness has come to Americans from recent developments is not the fault of those who have made the exposures, but of those whose conduct brought about a condition of things making exposure imperatively necessary.

New Publications.

"Complete Examination Questions and Answers for Marine and Stationary En-

gineers." By Calvin F. Swingle. 307 4½x7-inch pages, with 212 illustrations. Frederick J. Drake & Co., Chicago.

This book is an addition to the long list of operating engineers' catechisms, and does not differ materially from many of the others. It describes the leading types of boilers and engines together with auxiliary apparatus, and the indicator. A long chapter at the conclusion of the book is given to the steam turbine.

"A Plumbing Catechism." By C. B. Ball and H. T. Sheriff. 100 4½x6½-inch pages. Domestic Engineering. Chicago. Price, $1.

This book begins with a description of the various types and kinds of plumbing fixtures, and then takes up the subjects of water service pipes and the design of pipe systems. It is an elementary manual, and is intended chiefly for beginners.

"Dictionary of Engineering Terms in English and Spanish." By Andres J. R. V. Garcia. 150 4x5½-inch pages; Spon and Chamberlain. New York.

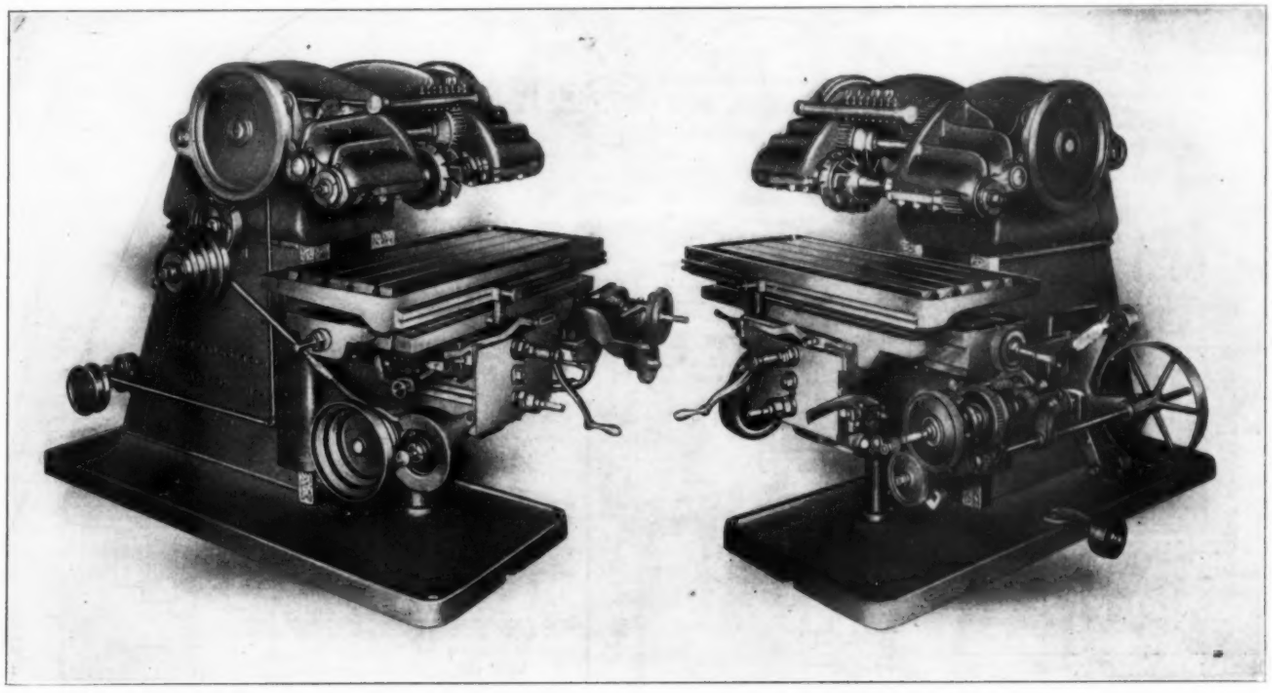
This little dictionary should find considerable use among machinery manufacturers and dealers who do business with Spanish-speaking countries. It is an English-Spanish dictionary but is made to serve the purpose of a Spanish-English dictionary by a full Spanish index. The author's native language is Spanish, and his selection of English terms is good and intelligent, leading one to expect corresponding qualities in the Spanish terms.

"The American Steel Worker." Second Edition. By E. R. Markham. 339 5½x8-inch pages, with 163 illustrations. The Derry-Collard Company, New York. Price, $2.50.

We are glad to note the appearance of the second edition of this excellent book, which contains, in addition to the contents of the first edition, a section on high-speed steel. No toolmaker or steelworker can make a mistake in buying a copy of this publication.

A Full Automatic Rack Cutter.

Figs. 1 and 2 give an idea of the general appearance of a new full automatic rack-cutting machine. The covers have been left off portions of the gearing in order to show the mechanism. The cutter spindle is driven from both ends, the drive upon the left side of the machine being by helical gears and upon the right by spur gears. This method of driving was adopted to eliminate vibration and chatter of the cutter and also to provide a powerful drive. The cutter arbor is shown in Fig. 3, together with the two spindles that drive it. *A* is the cutter arbor, having a tongue *J* at each end fitting into slots in the spindles *B* and *C*. One end of the arbor *A* has a flange integral with it, the other end is threaded for the nut which secures the cutters. The spindles are hollow and provided with two long studs *D* and *E* which screw into threaded holes in the ends of the spindle; the other ends of the studs are drawn up by the hexagonal nuts *F* and *G* against the washers *K*, the inside one of which is of fiber. The flange *H* on the spindle *B* is integral with the spindle, but *I* is a collar threaded to fit a fine thread on the spindle *C*, this permits adjustment end ways. The collar *I* is split and clamped securely to the spindle *C* when adjusted. The clamp collar *C* is clearly shown in Figs. 1 and 2. Fig. 4 shows the feed and quick-return mechanism. The feed being by worm gearing and the quick return by bevel gearing. The usual clutch is employed, actuated by lever from the feed trip dogs. Fig. 5 is a top and front view of the knee, showing the feed and quick-return mechanism.



FIGS. 1 AND 2. A FULL AUTOMATIC RACK CUTTER.

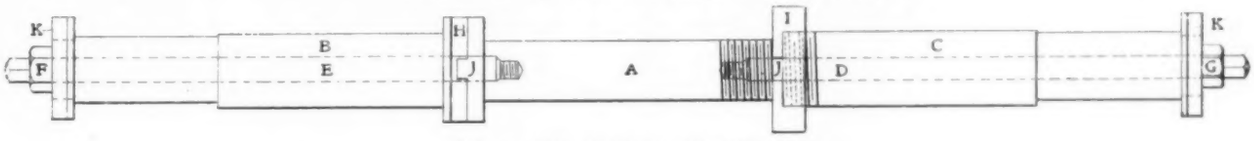


FIG. 3. THE SPINDLES AND THE ARBOR.

The main drive of the machine is to a cone situated behind the cutter arbor, from it a train of gears on either side drives the spindles. Another train of gears drives the cone on the left side of the main housing, this cone connects by belt with the cone on the knee which drives the feed and quick-return mechanism. On the right side of the machine is the indexing mechanism, driven from overhead. It consists of two disks, one for a stop and one for a roller. The stop disk being connected with the index screw by gearing. The stop disk and roller disk are connected through a differential shaft and change gears on the front of the apron. As the stop and roller are rigidly

fastened together they can both enter only when the opening on the stop disk comes fair with the opening on the roller disk. Thus when the stop and roller are withdrawn the stop disk may make any number of turns, from one to twelve, before the stop can enter again, by varying the multiple indexing change gears on the front of the apron. The change gears are so calculated that a single tooth of each pitch rack to be set over corresponds to a whole number of turns on the stop disk. Thus, having placed the proper change gear for any pitch of rack on the screw, and having placed the multiple indexing change gears on the front of the apron to set over the work the desired number of teeth, when the stop and roller are withdrawn by the indexing trip dog, the table will be automatically moved over the correct amount for the required number of teeth of the given pitch.

On the left-hand side of the machine below the table slide there is a chain which leads from a stop and over a pulley at the back of the machine up to the shifter rod. An adjustable lever on the front of the cross rail releases the chain, thus shutting down the machine. The adjustable lever can be set to shut the machine down when the table reaches any desired point either at or before the end of the blank is reached. The machine will mill a rack 36 inches long by 8 inches wide one diametral pitch or finer. It will index over any number of teeth within the capacity of the machine. It has a range of feeds from ½ inch to nearly 6 inches per minute and will cut one diametral pitch in steel, using one stocking and one finishing cutter, with a feed of ¾ inch per minute. With cutters of high speed steel faster feeds may be used. As the arbor has 10 inches of cutter space on it, it can be entirely filled with cutters when cutting the finer pitches, one-half of the cutters being for removing the surplus stock and the other half for finishing.

The machine is equipped with an oil pump and piping, the oil tank being inside the column. This machine is built by Geo. D. Wolcott & Son, Jackson, Michigan.

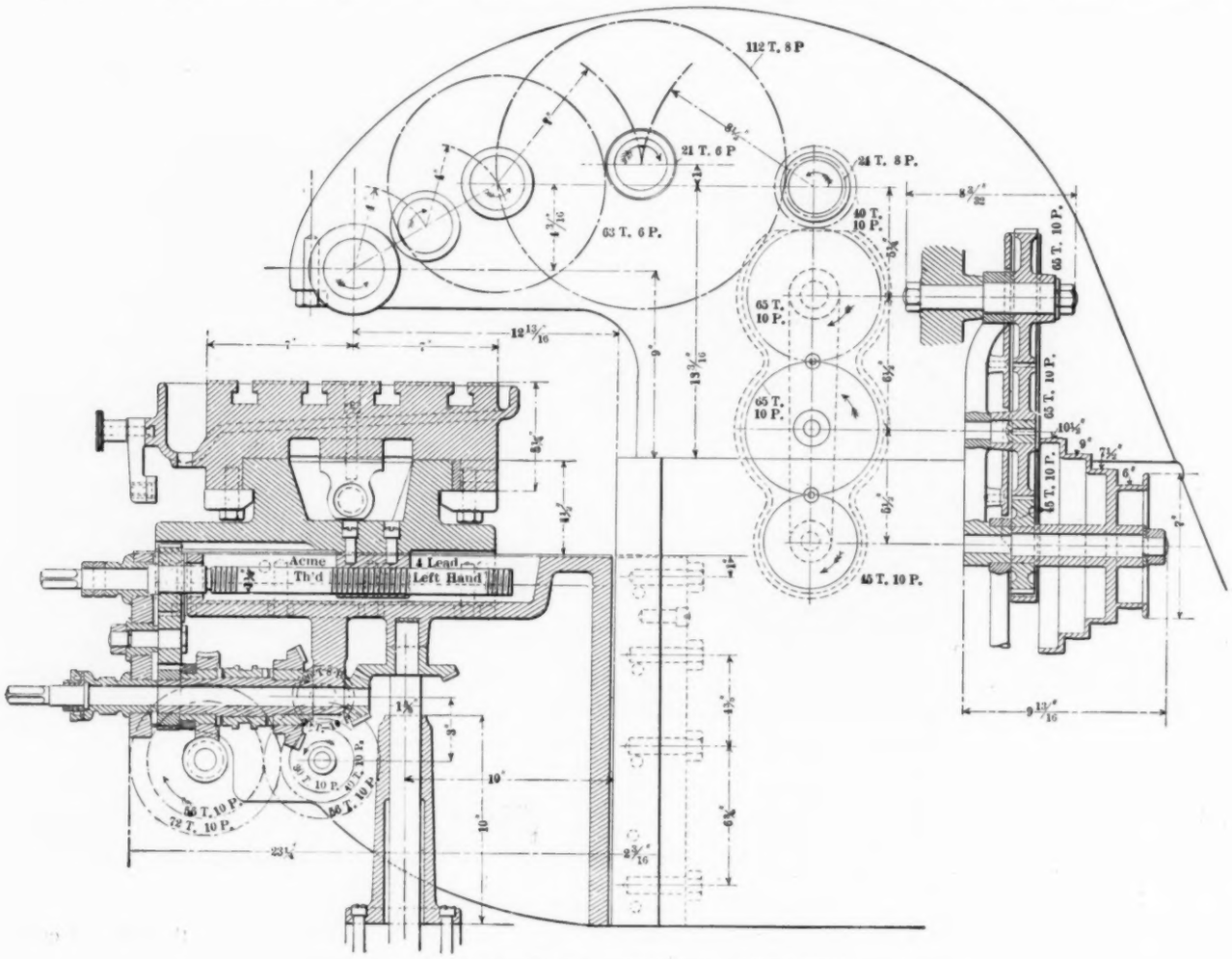


FIG. 4. SHOWING FEED AND QUICK-RETURN MECHANISM.

Zinc sheets may be rolled without cracking though they contain 1.5 per cent of lead; with as much as 3 per cent. of lead they may be rolled but the material is very weak; the effect of an increase in the percentage of lead being to make the metal weak and soft.

Worm Gear Design.

BY A. M. SOSA.

In the criticism offered at page 144 by Robert A. Bruce, of the five conclusions he arrives at, we may readily neglect two, numbers 2 and 3. According to conclusion 2, the end thrust varies directly with the diameter of the worm, and according to conclusion 3, the end thrust varies but little with the angle of the thread, while, on the other hand, the capacity of a worm for transmitting power is sensibly proportional to this angle. These conclusions agree exactly with my statements, and it remains to consider only conclusions 1, 4 and 5. I will consider conclusions 1 and 5 as complements of each other for the following reasons:

According to Mr. Bruce, the end-thrust W is independent of the pitch p, and p should not enter the formula. Also, the diameter of the wheel D affects the value of W, and D should be included in the formula. In my calculations, W varies as p, and I have neglected the diameter of the wheel D. According to Mr. Bruce, as the pitch diminishes the area of contact of one tooth diminishes, but there are a greater number of teeth in contact. Also,

with the change of diameter of the wheel the number of teeth in contact changes. It will be seen that the reason given in both cases is the same—that is, the number of teeth in contact. If we were to suppose only one tooth in contact at a time, Mr. Bruce and I would agree on these two points: 1. That the end thrust varies as the pitch. 2. That the diameter of the wheel should not enter the calculation.

I have assumed from the beginning that only one tooth at a time carries the load, and this assumption is made from a practical standpoint. Mr. Bruce considers the number of teeth in contact, from a theoretical standpoint. We both could be right, and if this were the case, my formula would give practical results.

Much has been said to substantiate the one-tooth contact theory of gearing, especially when workmanship has to be taken in consideration, practical results being the only certain basis to build upon. In assembling a machine, we color the teeth of the gears and run them to insure full bearing. An examination of the coloring shows that the bearing takes place on a small portion of the tooth near the pitch line. It is expected that the bearing will take place up to the limit line, but that is not the case, and it is not until very near the line of centers that each tooth, one at a time, takes the full load, the sliding motion of parts under very light pressure compensating in wear with those parts under heavy pressure and almost no sliding. Another indication is the shape of a worn-out tooth. If conditions were perfect, the tooth would wear down thinner, but maintaining its true involute shape. Unfortunately this is not the case. For these and similar reasons it has become the practice, in figuring gears, to depend exclusively on the work of one tooth.

If Mr. Bruce's theory were correct we could make the following conclusion: The allowable pressure on the teeth of two mating spur gears is constant for a given diameter and face. This pressure varies with the face of the gears, and in some way with their diameter, and is independent of the pitch, the reason for this being that the strength of the tooth is directly proportional to the pitch and inversely proportional to the number of teeth in contact. The finer the tooth, the more teeth are in contact; consequently, the allowable pressure on the teeth is independent of the pitch.

A formal proof of the above error seems unnecessary. Conforming with good practice, however, we do select as fine a pitch as possible to get better running gears. The more teeth are comprised within the line of action the easier is the running of the gears. This seems to perfect the action of approach, and is accomplished by, either or both, increase of diameter and decrease of pitch. This noticeable difference of action of running gears, due to the number of teeth in *contact*, must have its influence upon the gear endurance, but Mr. Bruce's simple law does not hold good.

Conclusion number 4 is rather complex. First is the statement that "the relationship between rubbing velocity and pressure is complex." Second, "that this relationship appears to depend more upon the nature, quantity, temperature conditions, and mode of application of the lubricant," etc. And third, the enunciation of a definite law:

$$W v^n = con.tant,$$

which does not comprise the main factors set forth, "nature, quantity, temperature conditions, and mode of application of the lubricant."

Here, again, I have made use of a well known theory, generally accepted: for a journal and bearing, "the pressure per

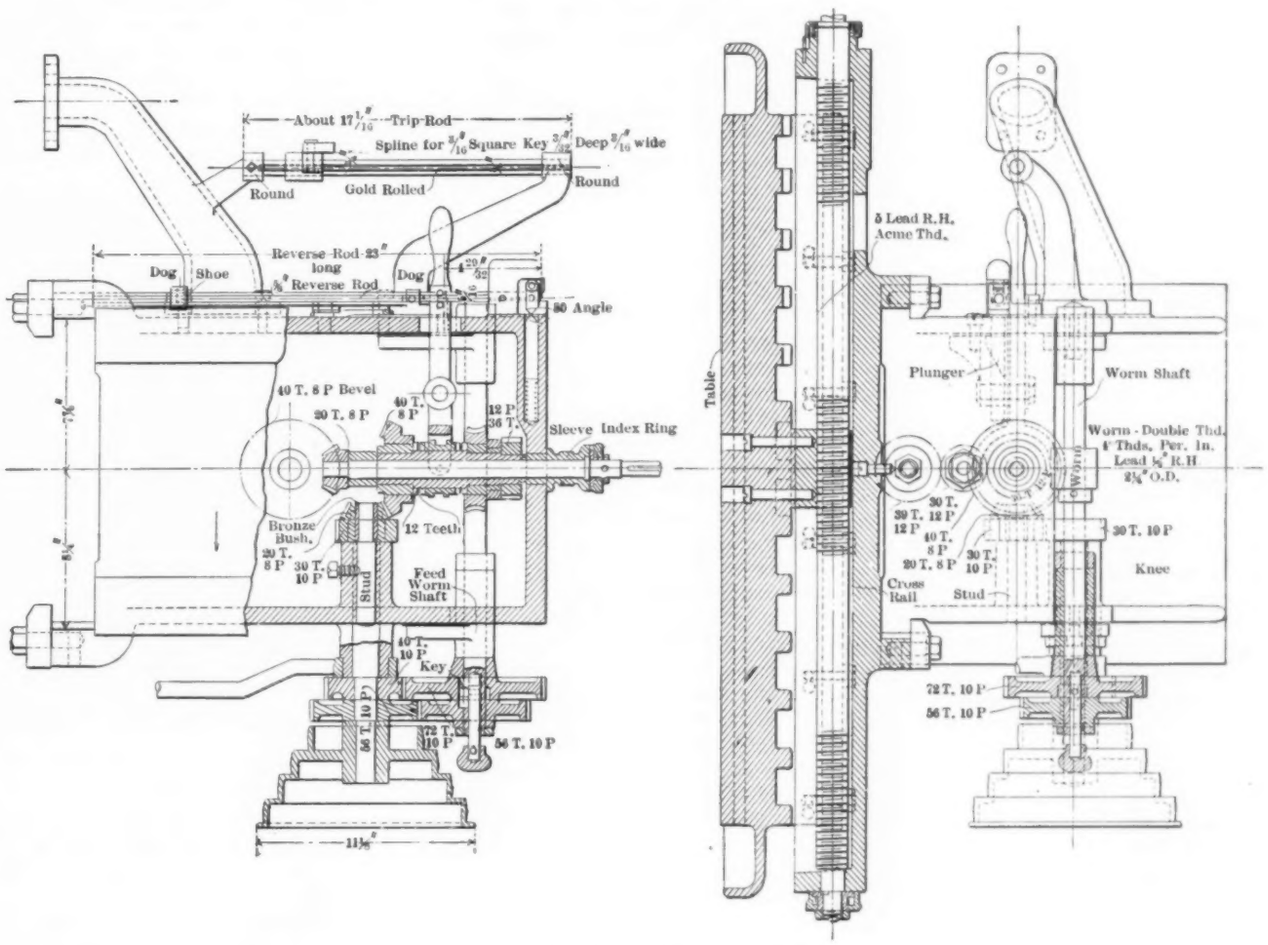


FIG. 5. TOP AND FRONT VIEWS OF THE KNEE.

unit area times the lineal rubbing velocity is a limiting constant within the limits of abrasion." This simple law does not take into account all the fine points of lubrication, etc., and might not satisfy a scientist, but it is good enough for all shop conditions.

Mr. Bruce's suggestion for simplifying my formula is justified for small angles, as I said originally, but not for large ones.

An Exposition ot Safety Devices.

The American Institute of Social Service will hold at the American Museum of Natural History, in New York City, commencing January 28th, 1907, an Exposition of devices for safeguarding the lives and limbs of working men and women, and for preventing accidents under ordinary conditions of life and labor to which the general public is exposed.

This will be the first Exposition of the kind in this country, and it is surprising to note how far behind other nations we are in this respect.

As far back as 1889 there was a German Exposition for the prevention of accidents. In 1893 an Exposition of this nature was held in Amsterdam, and since then there have been several similar expositions in continental Europe and Canada.

As an outgrowth of these national movements there have been organized several museums of security; one at Vienna in 1890, one at Amsterdam in 1893, one at Munich in 1900, one at Berlin in 1901, and one at Paris in 1905, and Russia, which we are inclined to look upon as semi-barbarous, has recently established a museum on a large scale in Moscow.

That these expositions and museums have been of real value to their respective countries is evinced by the comparative study of the number of accidents in Europe and in America, which shows that for the same number of men employed in a given trade, we have from two to nine times as many accidents as they have in European countries.

The perfection of modern firearms rendered the late conflict in Asia exceptionally bloody; and yet it can be shown that without reasonable doubt the casualties of our industrial army in the United States are at least fifty per cent. greater every year than the number of killed and wounded in both the Japanese and Russian armies.

Such conditions can exist only through general ignorance of their reality, and it is for the purpose of educating the public to an appreciation of the actual situation and the means of its improvement that the Exposition of Safety Devices is to be held.

The interest of manufacturers generally is solicited, as well as that of organizations whose special function is to improve the conditions of labor, and a widespread response is looked for to this request for representation in the nature of photographs, descriptive drawings, models, and as far as possible, the devices themselves in actual operation. Several months ago we published some pictures showing to some extent the character of devices intended to be shown, and such of our readers as supply these devices on their machines, will, we think, do well to send samples of them to the exposition. Following are some of the groups of exhibits:

SECTION 1. Models, photographs and drawings of scaffolding, as well as the personal equipment of workers in building trades. 2. Protective devices for boilers, water gages, signal apparatus, boiler and pipe valves; also protective devices for electrical machinery and acetylene apparatus. 3. Protective devices for motors and power transmitters, devices for turning on power and turning it oft, belt connection, couplings, etc. 4. Fire protection and the prevention of explosives. 5. First aid to the injured. 6. Mining and quarrying; devices in use on stone crushing machinery, etc. Storing of explosives. 7. Metal industry: safety devices for metal-working machinery. 8. Textile industry: safety devices for looms, carding, etc. 9. Leather and paper industry: safety devices for paper cutting, stamping and molding machinery. 10. Safety appliances for elevators and hoisting apparatus models. 11. Food products: safety appliances for kneading machines, rollers and cutters. 12. Personal equipment of workingmen: protective spectacles, respirators, suits, etc. 13. Workingmen's dwellings. 14 and 15. Housing: models, plans, photographs. 16. Ventilation. 17. Models, photographs and plans of toilets, dressing and living rooms, baths, etc. 18. Cooking: demonstration in heating food; models, plans, photographs. 19. Other social betterment institutions; reports of labor departments, industrial arbitration courts. 20. Agricultural machinery: safety appliances on same, demonstrated by models and views. 21. Lumber industry: safety devices for band and circular saws, planing machinery, etc., demonstrated by models. 22. Models, photographs and plans of workingmen's industrial betterment institutions of all kinds.

Requests for information regarding space should be made to Dr. William H. Tolman, Director, 287 Fourth Avenue, New York.

On July 22, the Grand Trunk Railway changed its double-track divisions which had been operated left-handed, to right-hand running, as is standard in the United States—though on the Chicago and Northwestern Railway, and the Lake Shore and Michigan Southern, trains are still run left-handed; and also convenience of operation at the Grand Central station in New York city causes the New York Central to operate left-handed from that point to Spuyten Duyvil.

New Tools and Machine Shop Appliances.

TWO PLAIN MILLING MACHINES.

Fig 1 shows a machine designed especially for heavy accurate work. By referring to the illustration it will be seen that the knee slide is extended to the top of the frame. This gives further support to the front-spindle bearing and permits the regular attachments to be clamped direct to the face of the column. The back gears are inclosed in the column of the machine under the cone and are operated by a lever on the right-hand side of the column.

The spindle has sixteen direct gradations of speed in geometrical progression from 13 to 439 r.p.m., and 8 reverse speeds ranging from 22 to 305 r.p.m. The overhanging arm is a solid bar of steel; it can be pushed back so as to clear the table when not in use. Both of its bearings are securely clamped by a single

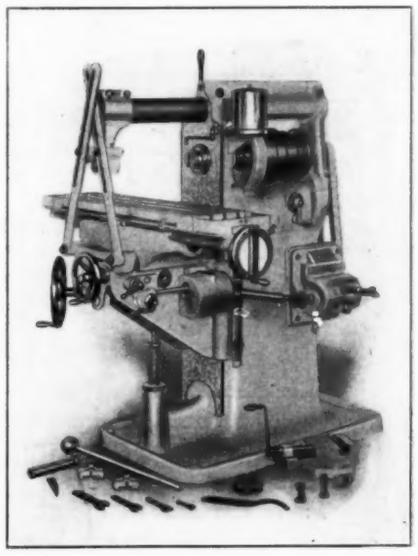


FIG. 1. A PLAIN MILLING MACHINE FOR HEAVY WORK.

lever within easy reach of the operator. The distance from the under side of the arm to the center of the spindle is 6⅜ inches.

The working surface of the table is 41½x11½ inches; it has 3 T-slots ⅝ inch wide.

The drive of the table is positive by chain direct from the spindle to the gear case. It has a longitudinal traverse of 28 inches, transverse 8 inches and vertical 19 inches, with 20 changes of automatic feed from 0.004 to 0.200 inch per revolution of the spindle. A quick return by means of an internal gear and pinion is provided for the table. The feed screw is not splined, an auxiliary shaft being provided for driving the clutch gears. This leaves the threads unbroken, prolongs the life of the screw and nut and maintains their accuracy.

The hand wheels for the cross and

vertical feeds are conveniently placed, they are provided with clutches easily engaged or disengaged so that the hand wheels may remain stationary after adjustments are made, thus avoiding accidental disturbance of settings.

The levers for controlling the various feeds are conveniently located at the right of the knee. One lever on the side of the reverse gear case serves to start, stop and reverse all feeds; the other two levers control respectively the automatic transverse and vertical feeds when machines are so equipped.

The feed-tripping mechanism on the front of the saddle is of the double plunger type and very sensitive. It can be set to prevent throwing in the wrong clutch and when the feed is tripped, it is not necessary to run the table dog beyond the trip plunger to reverse the feed, the reversing of the tripping lever being all that is required. This mechanism is in addition to that on the side of the knee.

Adjustable dials graduated to read to

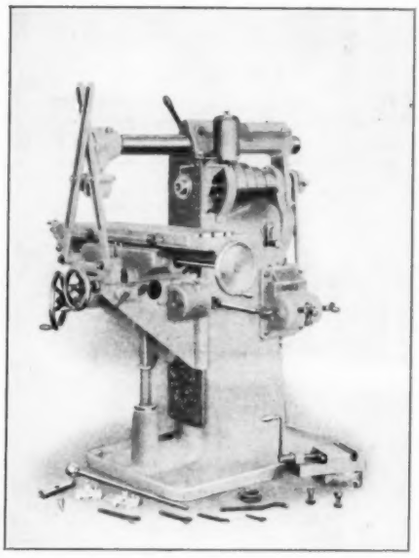


FIG. 2. A PLAIN MILLER FOR LIGHT WORK.

thousandths of an inch indicate the longitudinal, transverse and vertical movements of the table.

The frame is hollow, its walls are braced internally to resist vibration. The supports that carry the spindle bearings and overhanging arm are of solid metal, tied together by a brace that forms a part of the main casting. A rim around the base forms an oil pan for protecting the floor and adding to the stiffness of the floor bearing.

The vise is low. It is clamped by one bolt. It swivels and is graduated, thus enabling the vise to be readily set at any angle to the table ways. The jaws are of tool steel, hardened.

The counter shaft has 3 friction pulleys 14 inches diameter for 4-inch belts. The direct speeds are 120 and 308 revolutions per minute, the reverse speed is 214 revolutions per minute.

The approximate net weight of the machine is 3600 pounds.

The machine shown at Fig. 2 is of the same general construction as that shown at Fig. 1, but it is intended for lighter

FIG. 1. AS A SURFACE GRINDER.

plain milling in the tool room and for general jobbing purposes.

The table has a working surface 35x10¼ inches and 3 T-slots ⅝ inch wide. The longitudinal feed is 24 inches, transverse feed 7 inches, vertical feed 19 inches. Sixteen changes of direct-spindle speed are provided from 16 to 318 revolutions per minute, and 8 reverse speeds from 17 to 290 revolutions per minute. Distance from center of spindle to under side of overhanging arm 5½ inches; end of spindle to the center in the arbor support 16½ inches. The feeds are 20 in number, varying in practically geometric progression, from 0.003 to 0.150 inch per revolution of the spindle. The machine requires a floor space 80x56 inches and weighs about 2600 pounds.

These millers are made by the Brown & Sharpe Manufacturing Company, Providence, R. I.

A UNIVERSAL GRINDER.

The illustrations show various views of an improved universal grinder, the original of which we described and illustrated at page 566, Vol. 27, Part 1. All of these views were taken without moving the camera.

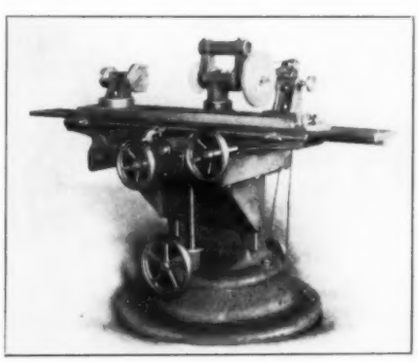


FIG. 2. GRINDING WORK ON CENTERS.

In this machine the grinding wheels are mounted upon a column solid with the base, and they remain in a fixed position. A sleeve surrounds the column and upon it the knee and table are secured. The sleeve, knee and superimposed table are capable of being swung around the column through an arc slightly more than

FIG. 3. ARRANGED FOR LARGE INTERNAL GRINDING.

180 degrees. This construction permits the work to be brought to the wheel and not the wheel to the work.

Knife grinding can be done the full length of the table—48 inches. Surface grinding, for which the machine is arranged in Fig. 1, can be done up to 7x36 inches. Cylindrical grinding, 10x36 inches, is possible with the heads shown in Fig. 2. Taper grinding can also be done with these heads.

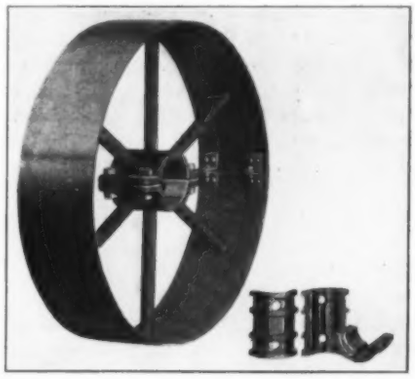
Internal grinding, from the smallest up to the full swing of the machine, may be done by the use of the high-speed spindle —this spindle we illustrated at page 566, Vol. 27, Part I.

Large internal grinding, up to 30 inches diameter by 3 inches deep, may be done by allowing the work to overhang the edge of the table, as shown in Fig. 3.

This grinder is manufactured by the Thompson Grinder Company, Springfield, Ohio.

A STEEL SPLIT PULLEY.

The illustration shows a split pulley having a steel rim and arms of bar steel secured to the rim and hub without the use of rivets. The rim of each half section is made of one piece of steel and



A STEEL SPLIT PULLEY.

has steel lugs riveted on at the joints to accommodate the bolts which hold the halves together.

The pulley is held to the shaft by compression. Bolts for this purpose pass through both sides of the hub close to the shaft. Loose bushings, also in halves, permit the pulley to be bushed to suit the shaft.

These pulleys are made in all standard sizes from 12 to 50 inches diameter and from 3 to 24 inches either crown or straight face. Six arms are used on all pulleys from 12 to 28 inches diameter, inclusive, by 3 to 12 inches face, also inclusive. Double sets of 6 arms are used on pulleys from 12 to 28 inches diameter by 14 to 24 inches face.

Eight arms are used on pulleys from 30 to 50 inches diameter by 4 to 12 inches face and double sets of 8 arms are used on pulleys from 30 to 50 inches diameter by 14 to 24 inches face.

They are manufactured by the Latshaw Pressed Steel and Pulley Company, Pittsburg, Penn., U. S. A.

Personal.

Mr. and Mrs. Amos Whitney will celebrate the fiftieth anniversary of their wedding at Hartford, Conn., September 8.

Arthur Appleton, formerly with William Sellers & Co., has been made the New York manager for the well-known builders of traveling cranes. Pawling & Harnischfeger, of Milwaukee, Wis. Mr. Appleton's office will be at 45 Broadway.

H. A. Sedgewick, for several years superintendent of Gay & Ward, Inc., Athol, Mass., and later connected with The Union Twist Drill Company, has resigned his position to become superintendent of Madison Kipp Lubricator Company, of Madison, Wis.

Obituary.

Dexter Reynolds, a prominent inventor and lawyer of Albany, N. Y., died at that place Aug. 20, aged 78. Mr. Reynolds patented twenty inventions, including a typewriting machine. He was connected for many years with the law firm of Marcus T. & Leonard G. Hun.

Cyrenius N. Squires, a pioneer in the rubber industry and an inventor of much of the apparatus used in manufacturing rubber goods, died at his home in Naugatuck, Conn., Aug. 20, 74 years old. Mr. Squires was associated with Charles Goodyear in experimenting with rubber to make it practicable for gloves, footwear and clothing.

E. Thomas Hannam, general sales manager of the Atlas Engine Works, Indianapolis, died suddenly on Aug. 18, in Chicago, of heart failure. Mr. Hannam, whose home was in Philadelphia, was in the West on a business trip, and was stricken while about to board a train. Mr. Hannam was an inventor of some prominence. He devised among other inventions a water-tube boiler. He began life as an apprentice in the machine shops of the Baltimore and Ohio Railroad, in Baltimore. He was a member of the American Society of Mechanical Engineers, of New York, and of the Manufacturers' and Engineers' clubs, of Philadelphia.

Business Items.

The R. D. Nuttall Company, Pittsburg, Pa., has ordered equipment for its small-gear department, particularly for the manufacture of automobile gears, which will practically double the output of bevels and worm gearing.

Manufactures.

John J. Kennedy will start a foundry in Lewiston, Maine.

William Buchheim, Albany, N. Y., will build a large dye factory.

The Murphy Varnish Works, Newark, N. J., will build a $100,000 factory.

The Malleable Iron Works, of Troy, N. Y., will greatly enlarge its plant.

The Sanitary Can Company, Fairport, N. Y., will enlarge its plant.

The La Crosse (Wis.) Boiler Company, is having plans drawn for a new plant.

The Western Electric Company, Chicago, Ill., will build a wire factory in Hawthorne.

The Russell & Erwin Company will build an addition to its plant in New Britain, Conn.

The Potomac Electric Power Company, Washington, D. C., will erect a $15,000 power house.

A new company, known as the Perry Iron Company, will erect a large iron furnace in Erie, Pa.

The Union Typewriter Company, Bridgeport, Conn., is to build a large addition to its present factory.

The Grand Rapids (Mich.) Refrigerator Company will put up a larger and better equipped factory.

The Ransome Concrete Machinery Company, 11 Broadway, New York, is erecting a plant in Plainfield, N. J.

The Pittsburg (Penn.) Steel Construction Company will double the capacity of its works at Economy.

The Coe Brass Manufacturing Company, of Torrington, Conn., is having plans drawn for a new machine shop.

A one-story boiler-house addition will be erected at the Women's Homeopathic Hospital, Philadelphia, Pa.

The Couple Gear Freight Company, of Grand Rapids, Mich., will build a new factory to cost nearly $100,000.

The Savage Arms Company will enlarge its plant in Utica, N. Y., and much new machinery will be installed.

The Kart-Parr Gasoline Engine Company, of Charles City, Iowa, is considering plans for the erection of a new plant.

The South Bend (Ind.) Paper Company will erect a plant in Fulton, N. Y., for the manufacture of paper bags.

The Skinner Chuck Manufacturing Company will add a new power house to its plant in New Britain, Conn.

The Lane & Bodley Company, Cincinnati, Ohio, machinery, engines, etc., will put up a new building to cost $12,000.

The American Can Company, New York, will erect a plant in New Castle, Penn., which will employ 1800 men.

The Maisby Machinery Company, Atlanta, Ga., has purchased some land on which it probably will erect a new plant.

The American Car and Foundry Company will erect a large steel-car manufacturing plant on South First street, St. Louis, Mo.

The Ansonia (Conn.) Manufacturing Company, of Ansonia, makers of brass goods, is building an extensive addition to its plant.

S. W. Raudenbush & Company will erect a piano factory in St. Paul, Minn., with an output of over a thousand instruments yearly.

It is said that the Page Woven Wire Fence Company, Adrian, Mich., is going into the automobile business will erect a plant in Detroit.

The Ackroyd Radiator Company will erect a plant in Plainfield, N. J., to manufacture a radiator invented by John H. Ackroyd, of that place.

The Michigan Copper and Brass Company is building a large factory on River street, Detroit, Michigan. The main building is to cost $96,000.

The L. S. Starrett Company is making a large addition to its plant in Athol, Mass. The new building will be of brick, 288 by 35 feet, and four stories high.

The General Electric Company, Lynn, Mass., has secured a factory building in East Boston, which will be used for the manufacture of incandescent lamps.

The Atlanta (Ga.) Plow Company, a new concern capitalized at $50,000, has secured site for a plant. J. W. Hightower, G. B. Brown, and others, incorporators.

The Dupont Powder Company will erect a million-dollar plant in Colorado, near Denver. The Western general offices of the company are in the Opera House block, Denver, Colo.

The Steele & Johnson Company, of Waterbury, Conn., manufacturers of stamped brass goods, has awarded the contract to erect a four-story brick factory building, 40 by 100 feet.

The Watervliet Foundry and Machine Company has recently been incorporated, and will erect a plant in Watervliet, N. Y. Harry B. and George B. Kelley, of Troy, N. Y., are directors.

Work has begun on the five-story brick addition of the plant of the Hartford (Conn.) Manufacturing Company, makers of Government stamped envelopes. The new factory is to be ready for occupancy by Nov. 1. The addition will contain 15,000 feet of floor space.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Runnerless slide rules. F. F. Nickel, 27 Winans street, East Orange, N. J.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—One No. 2 Brown & Sharpe wire-feed screw machine with automatic feed. Box 961, AMERICAN MACHINIST.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—26"x48"x14' McCabe D spindle lathe; must be in good condition. Address Woods Engineering Co., Alliance, O.

Work wanted for a Cleveland automatic

lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

Specialties made on contract for marine, automobile and general use and general machine shop work on brass goods. Lovell McConnell Mfg. Co., Newark, N. J.

Estimate wanted on furnishing 16 cast-iron steam boxes, 38x48x6; planed flat one side, weighing 1500 lbs. each. Write for specifications and blue print. Box 983, Am. M.

Wanted—Worms, spirals and screws to cut. We are equipped with special machines for milling these parts. Get our prices on doing some of your difficult jobs, Parsons & Lane, Sodus, N. Y.

Wanted—One Cleveland automatic screw machine with spindle capacity of from one to two inches, 1-inch size preferred; must be present style construction and in good order. Give serial number, price and full particulars. L. C. Smith & Bros. Typewriter Co., Syracuse, N. Y.

The University of Cincinnati has a few positions to offer energetic young men who desire to take an engineering course while supporting themselves in large measure by working as apprentices in the machine plants of Cincinnati. For information apply to Secretary, University of Cincinnati, Cincinnati, O.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

For Sale.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Going machine shop, situated in northern Ohio; natural gas; will bear strict investigation; good reason for selling. Address Box 525, Tiffin, Ohio,

$50,000 buys plant, manufacturing own patented machines, in operation throughout the country, including patents, machinery, factory, tools, jigs, good will; 15 miles from New York City; doing good business. Box 958, American Machinist.

Business Opportunities.

Wanted—Capital to start manufacturing patented cutter and reamer. This is a money and labor-saving tool, something which will sell on sight. Would consider proposition of a firm desiring to add new line of manufacturing. Address Box 926, Amer. Machinist.

Wants.

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Wanted—Position by an experienced cost man, familiar with the best factory methods, the premium system for remunerating labor and the handling of men. Box 968, Am. M.

CONNECTICUT.

Superintendent, with extensive and varied practical mechanical experience; designs special tools, dies and machinery; up-to-date in organization, stock, tool and cost systems; American; age 45; minimum salary $3000; locate anywhere; open Sept 1. Address Box 965, American Machinist.

Superintendent of an extensive manufacturing plant desires to make a change; accustomed to the latest and best machine-shop methods and practice; capable of organizing and handling a machinery plant in all its branches; a designer of special and automatic machinery, tools, jigs and fixtures for the rapid and economical production of fine and medium heavy interchangeable work. Box 950, American Machinist.

MASSACHUSETTS.

Wanted—Position where inventive mechanical ability is required. I am 34, single, technical graduate, with 14 years' shop and drafting experience. Box 927, Amer. Machinist.

NEW JERSEY.

Mechanical draftsman desires position. Box 985, American Machinist.

Superintendent or general foreman; age 32; 16 years' experience on light and heavy machinery, jig and duplicate work; good executive; best references. Box 969, Amer. Mach.

Young man, M. E., desires position as superintendent, assistant, or position of responsibility; good shop, drawing room and business experience on engines, pumps, condensers, etc.; good executive ability; best of references. Box 981, American Machinist.

Position wanted as superintendent of small shop or assistant superintendent of large shop by experienced foreman instrument maker and practical mechanic; possess good executive ability; system and piece-work methods well understood; any location; American; age 30. Address Box 964, Amer. Machinist.

Accountant, auditor, office manager, of executive ability, desires permanent engagement; 15 years with large manufacturing corporation, several years public-accounting; experienced in centralizing, organizing, installing labor-saving and result-producing methods; full comprehension cost accounts, capable to direct large force and handle details. Accountant, Box 941, American Machinist.

NEW YORK.

Wanted—Master machinist desires to make a change; 20 years' experience on kerosene, gas and gasoline engines. Box 984, Am. M.

Up-to-date machine-shop foreman of good inventive ability is open for engagement; experienced on special machinery, dies, etc. Box 979, American Machinist.

Wanted—Position as general foreman or assistant superintendent; first-class machinist and draftsman; technical and practical experience. Box 972, American Machinist.

Draftsman, with 10 years' shop and 2½ years' drawing experience on shop tools, automatic machinery, etc., desires position; some outside experience. Box 986, Amer. Mach.

Machine-shop foreman desires change; experienced on electrical machinery and automatic electrical apparatus; also understands erection of power plants Box 935, Am. M.

Draftsman, mechanical, young man, 22, technical graduate, designing ability, shop experience, good detailer, neat tracer, desires permanent and advancing position. Box 980, American Machinist.

General foreman—successful in producing first-class work at satisfactory cost, varied experience in building high-grade machinery, practical mechanic—desires change; $36 a week to start. Box 954, Amer. Machinist.

Wanted—Position as assistant superintendent or general foreman; can furnish best of references; know how to get out of high-speed steel all there is in it; can handle men to the best advantage; will guarantee results. Box 955, American Machinist.

OHIO.

Chief draftsman, machine tools, wants change; technical graduate, 31 years of age and married; best of references. Box 970, American Machinist.

American, with wide experience as designing draftsman, engineer and machinist, wishes position where not confined to office all the time; references include present employers. Box 973, American Machinist.

Young man wishes to connect with manufacturing concern; technical education, 27 years old, experienced traveling salesman; speaks Spanish and German; entire experience has been along mechanical lines. Box 972, Am. M.

First-class designer, with six years' experience on air compressors and steam engines—Corliss and piston-valve types—desires to change; have had two years general machine-shop practice and am thoroughly familiar with up-to-date constructions. Address Box 956, American Machinist.

Manager of manufacturing or engineering plant by a thoroughly practical and technical man, with exceptional ability and broad experience; knows his business from the bottom up; only positions requiring high-grade men considered; American; 38; locate anywhere. Box 976, American Machinist.

PENNSYLVANIA.

Patternmaker foreman would like to make a change; young man, 14 years' experience; six years foreman with present firm; best of references. Box 932, American Machinist.

Pattern-shop foreman wishes position; practical and experienced; thoroughly familiar with intricate core work and modern foundry practices; 7 years in charge at last place; best of references. G. A. J., Box 942, Amer. Mach.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

We are increasing our tool department and invite applications from toolmakers experienced on fixtures, dies and gages. Address, with full particulars as to experience and wages required, Ross Rifle Company, Quebec.

CONNECTICUT.

Tool and gauge makers wanted—Several first-class men on jig fixtures and gauge work; steady employment. Apply to Box 959, American Machinist.

Wanted—A first-class blacksmith on heavy machine forging. Address, stating experience and salary required, Farrel Foundry and Machine Co., Ansonia, Conn.

Diemakers wanted—Several first-class diemakers for punching, bending and blanking dies; steady employment and good wages. Address Box 960, American Machinist.

Wanted—Man who is capable of managing an office of a manufacturing plant and attending to correspondence; must understand bookkeeping, cost system and have economical ideas. Address P. O. Box 116, Bridgeport.

ILLINOIS.

Wanted—Three or four machinists, one with outside experience; chance for good men to advance. Box 933, American Machinist.

Wanted—Young mechanical draftsmen, two to four years out of college and experienced in complicated mechanism. Box 949, Am. M.

Wanted—A man to take charge of tool room. We desire an energetic, wide-awake man who understands good tool practice, with ambition enough to keep him on the alert for better methods; factory in Chicago. Box 977, American Machinist.

Wanted—An experienced factory superintendent for the manufacture of a variety of metal specialties; man must be of good character, reliable, painstaking, mentally alert, and a thorough master of detail. The factory is new and well equipped. Salary $2000 per year, but superintendent must make cash investment of $3000 and contract for three years. Box 871, American Machinist.

MAINE.

Wanted—A working foreman for a brass foundry; one who is well acquainted with the mixing, molding and finishing of brass castings. Reply, stating experience, with references, to Box 939, American Machinist.

MARYLAND.

Wanted—Toolmakers on automobile work. Address "P," Box 937, American Machinist.

Wanted—A man to act as master mechanic and to superintend the designing of all tools and fixtures for the interchangeable and economical manufacture of large quantities of automobiles; steady position to right man with one of the largest automobile manufacturers. Box 909, American Machinist.

MASSACHUSETTS.

Two or three first-class toolmakers; steady work; good pay. Address Lock Drawer 26, Boston, Mass.

Three or four first-class all-around machinists; steady work; good pay. Address Lock Drawer 26, Boston, Mass.

Wanted—Two or three first-class metal patternmakers; steady work; good pay Address Lock Drawer 26, Boston, Mass

Wanted—Young man familiar with machine tools, graduate of some technical school, to take charge of our catalog and circular department. Hill, Clarke & Co., 156 Oliver St., Boston, Mass.

MICHIGAN.

General foreman for machine shop manufacturing stapling and special machinery; must have first-class mechanical and executive ability; must be posted in modern methods and be able to reduce shop costs; state experience, wages and reference. Box 988, American Machinist.

Wanted — Experienced mechanical draftsman by a large concern building railway supplies; must be able to do detail designing in a practical manner; man familiar with both structural steel and light car work preferred; permanent employment to right party; references required. Address Car Builder, Box 912, American Machinist.

Wanted—Our annual vacation comes between the dates of Aug. 11 and 27; immediately after this time we will need a number of first-class toolmakers. We want only men who have had experience on accurate tools, jigs and fixtures for interchangeable machinery, and to such we can offer steady work at good wages. Box 911, American Machinist.

MINNESOTA.

Wanted — First-class machinists, moulders and patternmakers, also structural template makers and structural iron workers. We are

daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

NEW HAMPSHIRE.

Wanted — A thoroughly reliable and hustling master mechanic or shop foreman who can handle 100 or more good American workmen to best advantage and get out a good production; must be competent designer of tools and jigs for making in duplicate medium automatic machinery accurately and cheaply; conversant with up-to-date machine-shop methods and organization. Address, giving experience, references and salary expected. Box 878, AMERICAN MACHINIST.

NEW JERSEY.

Wanted—Machinists to build brass instruments; good wages to right men. Address 278 Ridgewood avenue, Ridgewood, N. J.

Draftsmen—Practical men on general engineering work for plant 25 miles from New York; state age, experience and salary. Box 940, AMERICAN MACHINIST.

Wanted—Lathe, planer, drill, boring mill and floor hands, also apprentice hands of two or three years' experience; good wages; open shop. Krom Machine Works, Plainfield, N. J.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chase Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Foreman for machine shop in New York City; state experience and references. Address Box 982, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Draftsmen on jigs, fixtures and tools wanted; experienced men only. Mergenthaler Linotype Co., 29-42 Ryerson street, Brooklyn, N. Y.

First-class diemakers who can file dies for cutting thin sheet metal; state age and experience. Oneida Community, Ltd., Sherrill, N. Y.

Wanted—By a large manufacturing concern, several detail draftsmen and tracers on machine and tool work. Write, giving age and experience, F. G. H., Box 916, AMER. MACH.

Wanted—Draftsmen, first-class, thoroughly up-to-date on modern cement machinery and mill installation; location near New York City. Address "X. Y. Z.," Box 962, AM. M.

Superintendent—Manufacturing plant, 600 hands, wants man of experience to take charge of manufacturing; first-class man, with A-1 references required. Address "A-1," Box 963, AMERICAN MACHINIST.

Draftsmen wanted on details of light wood and steel construction work; accuracy in dimensions essential; good jobs for good men; state age, experience and salary expected. Address Box 899, AMERICAN MACHINIST.

Machinery salesman wanted; must have a good knowledge of mechanics and be able to estimate; state age, salary and experience, otherwise application will not be considered. Address "M. S.," P. O. Box 1844, N. Y. City.

Wanted—Experienced mechanic who understands thoroughly turrets, automatic machines, and the like, to represent a well known concern, calling on the leading iron and steel industries in the State of Ohio; state age, experience, salary expected at the start Box 957, AMERICAN MACHINIST.

Wanted — A master mechanic by a large manufacturing concern; must thoroughly understand engines, boilers, dynamos, motors, piping, millwright and carpenter work; must have good executive ability and be able to take charge of entire up-keep of plant; give detailed experience, age, salary expected and references. Box 943, AMERICAN MACHINIST.

OHIO.

Wanted—By the Bickford Drill and Tool Company, Cincinnati, O., experienced toolmakers, vise and scraper hands.

Machine-shop foreman wanted to take charge of 60 to 100 men on medium size tools; state age, experience and salary. Address Box 975, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists The American Tool Works Co., Cincinnati.

Wanted — Competent toolmakers familiar with fine work on small punches, dies and small jig work; permanent position with good pay under best of conditions. Box 925, AMERICAN MACHINIST.

Wanted—Young man familiar with details of heavy engine construction and manufacturing costs as assistant in sales department; technical graduate with business experience preferred. Address Box 946, AMER. MACH.

Wanted—Three first-class draftsmen familiar with the design and construction of electric traveling cranes; also one structural draftsman; permanent position and good wages guaranteed; only experienced men need apply. Address Case Mfg. Co., Columbus, O.

PENNSYLVANIA.

Wanted — First-class machinists and toolmakers; good wages to right parties; no labor troubles. Box 857, AMERICAN MACHINIST.

Wanted — Thoroughly experienced erecting machinists, accustomed to steam engine or compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Competent man for layer-out in boiler shop; must be up-to-date in all branches of boiler, tank and sheet-iron work; give age, where last employed and wages expected. Address "Layer-out," Box 974, AMER. MACHINIST.

Die sinker thoroughly experienced on drop-forge dies; permanent position at good wages guaranteed capable man, competent to lay out, design and estimate upon all classes of drop-forge work Box 966, AMER. MACHINIST.

General foreman—Must have technical education, be a first-class machinist and thoroughly familiar with the fabrication of structural steel, blacksmithing, etc.; must have executive ability and be familiar with rapid and economical production; an opportunity for a high-grade man to connect himself with a growing concern. Box 978, AMER. MACH.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

VERMONT.

Wanted—A young draftsman with some experience on textile machinery; one who has also worked in machine shop preferred. Box 938, AMERICAN MACHINIST

WISCONSIN.

As the result of doubling its new West Allis plant, Allis-Chalmers Co., Milwaukee, needs more patternmakers, machinists and moulders.

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, moulders and boilermakers can find steady employment. Box 899, Milwaukee, Wis.

Wanted—A few first-class machinists, toolmakers and patternmakers; shop one of the best in the country and equipped throughout with the highest grade of tools; city one of the best in the country; educational facilities of the best; pure water, etc.; only steady, reliable men looking for permanent positions need apply. Address Box 848, AMER. MACH.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., is constantly increasing its works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

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